Industrial QUALITY CONTROL

Vol. XIV, No. 5
November, 1957

In This Issue

A New ASQC Standard Is Established

Control Charts With "Movable" Limits

Latent Reliability

Controlling the Quality of Magnesium Alloy Castings

QUALITY
through
Scientific Methods

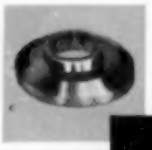
Journal of the
AMERICAN SOCIETY FOR QUALITY CONTROL

Speed Inspection
OF PRODUCTION PARTS!

NEW **DEARBORNAIRE**

MULTIPLE COLUMN AIR GAGING INSTRUMENTS

Special Air Gaging Fixtures designed and built to meet your particular application requirements. Complete engineering service available upon request.



Send part print showing all dimensions to be checked and tolerances required for prompt quotation and delivery.

To speed inspection of production parts, new Dearbornaire air gaging instruments are now offered in multiple column units designed to permit more accurate simultaneous checking of as many dimensions as may be required for a given part. What's more, each unit incorporates all of the advanced design features which have made Dearbornaire the most practical, most versatile column type instrument ever produced . . .

- New higher rated pressure system and built-in circuit restrictions make them virtually self-cleaning, reduce maintenance to a minimum.
- New glass tube has a characterized internal taper which provides positive linear accuracy over the full extent of the calibrated scales.
- Easy-to-read Zero-centered scales permit use of instrument for normal inspection, statistical quality control, and as a tool setting gage.
- Interchangeability of component parts simplifies conversion from one amplification to another, reduces spare parts inventory costs.

Plus a complete line of air gage spindles, rings, snaps and cartridges all precision finished to give you greater accuracy, longer wear life. Free demonstration arranged upon request. Write for details today!

AIR GAGE DIVISION
DEARBORN GAGE COMPANY
22038 Beech Street • Dearborn, Michigan

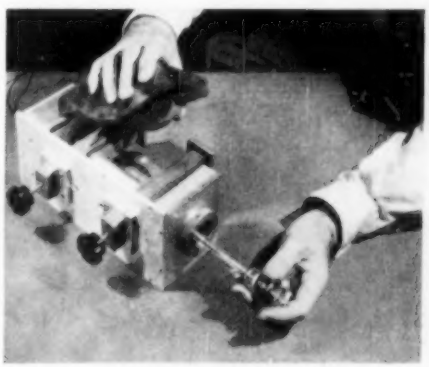
A GREAT AMPLIFIER TUBE IS PERFECTED FOR TELEPHONY

A new transcontinental microwave system capable of carrying four times as much information as any previous microwave system is under development at Bell Laboratories. A master key to this development is a new traveling-wave tube of large frequency bandwidth.

The traveling-wave amplifying principle was discovered in England by Dr. Rudolf Kompfner, who is now at Bell Laboratories; the fundamental theory was largely developed by Labs scientist Dr. John Pierce. Subsequently the tube has been utilized in various ways both here and abroad. At the Laboratories it has been perfected to meet the exacting performance standards of long distance telephony. And now for the first time a traveling-wave tube will go into large-scale production for use in our nation's telephone systems.

The new amplifier's tremendous bandwidth greatly simplifies the practical problem of operating and maintaining microwave communications. For example, in the proposed transcontinental system, as many as 16 different one-way radio channels will be used to transmit a capacity load of more than 11,000 conversations or 12 television programs and 2500 conversations. Formerly it would have been necessary to tune several amplifier tubes to match each channel. In contrast, a single traveling-wave tube can supply all the amplification needed for a channel. Tubes can be interchanged with only very minor adjustments.

The new amplifier is another example of how Bell Laboratories research creates new devices and new systems for telephony.



Left: A traveling-wave tube. *Right:* Tube being placed in position between the permanent magnets which focus the electron beam. The tube supplies uniform and distortionless amplification of FM signals over a 500 Mc band. It will be used to deliver an output of five watts.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

EDITORIAL BOARD

MASON E. WESCOTT, *Chairman*
University College, Rutgers University, New Brunswick, N. J.

CHARLES A. BICKING
The Carborundum Co.

ALBERT H. BOWKER
Stanford University

A. C. COHEN, JR.
University of Georgia

ALLEN T. CRAIG
State University of Iowa

CECIL C. CRAIG
University of Michigan

ACHESON J. DUNCAN
Johns Hopkins University

A. V. FEIGENBAUM
General Electric Co.

ENOCH B. FERRELL
Bell Telephone Laboratories, Inc.

DAME S. HAMBY
North Carolina State College

CHARLES R. HICKS
Purdue University

EDGAR P. KING
Eli Lilly & Co.

B. H. LLOYD
Leetham, Simpson & Elliott, Ltd.

PAUL S. OLMSTEAD
Bell Telephone Laboratories, Inc.

WILLIAM R. PABST, JR.
Bureau of Ordnance, Department of the Navy

EDWARD M. SCHROCK
American Radiator and Standard Sanitary Corp.

1957-58 SOCIETY OFFICERS

President
LEON BASS
General Electric Co.
Cincinnati, Ohio

Vice Presidents
HENRY J. BECKER
American Steel & Wire Div.
U. S. Steel Corp.
Waukegan, Ill.

CLARENCE R. BURDICK
Houdaille Industries, Inc.
Detroit, Mich.

C. E. FISHER
Bell Telephone Laboratories, Inc.
New York, N. Y.

ELLIS R. OTT
Rutgers University
New Brunswick, N. J.

Executive Secretary
L. S. EICHELBERGER
A. O. Smith Corp.
Milwaukee, Wis.

Treasurer
J. Y. MCCLURE
Convair Div. of
General Dynamics Corp.
Ft. Worth, Texas

Junior Past President
DALE L. LOBSINGER
United Air Lines
Denver, Colo.

1957-58 EXECUTIVE DIRECTORS

D. G. BROWNE
The Broderick Co.
Muncie, Ind.

ROCCO L. FIASCHETTI
Ansco-General Aniline & Film Corp.
Binghamton, N. Y.

RALPH D. HUMPHRIES
Cessna Aircraft Co.
Wichita, Kans.

AUGUST B. MUNDEL
Sonotone Corp.
Elmsford, N. Y.

HARRY G. ROMIG
Paper-Mate Mfg. Co.
Culver City, Calif.

ADVISORY COUNCIL

E. U. CONDON, *Chairman*
Department of Physics
Washington University
St. Louis, Missouri

M. HERBERT EISENHART, *Chairman*
Bausch & Lomb Optical Co.
Rochester, New York

HERMON F. SAFFORD, *President*
Ohio Rubber Co.
Willoughby, Ohio

WALTER A. SHEWHART, *Retired*
Bell Telephone Laboratories, Inc.
Murray Hill, New Jersey

DIVISIONS OF ASQC

Administrative Applications Division
PAUL A. ROBERT
Precision Products Co. of Cincinnati
Norwood, Ohio

Aircraft Division
RALPH D. HUMPHRIES
Cessna Aircraft Co.
Wichita, Kans.

Automotive Division
STANLEY B. SHERWOOD
General Motors Technical Center
Detroit, Mich.

Chemical Division
MAYNARD S. RENNER
Dewey and Almy Chemical Co.
Cambridge, Mass.

Electronics Division
IRVIN W. SCHOENINGER
Globe Union, Inc.
Milwaukee, Wis.

Textile Division
JAMES B. CURLEY
American Viscose Corp.
Marcus Hook, Pa.

INDUSTRIAL

Quality Control

Vol. XIV, No. 5 November, 1957

EDITOR:
Mason E. Wescott

BUSINESS MANAGER
William P. Youngclaus, Jr.

MANAGING EDITOR:
George R. Foster

PRODUCTION:
Alan T. Zingelman

DEPARTMENT EDITORS:

Joseph Movshin, Bibliography
W. D. Baten, Book Reviews
P. C. Clifford, T. A. Budne, Problems
E. R. Ott, Practical Aids
R. A. Wylie, What's New
J. M. Juran, Management's Corner
M. E. Wescott, Scrap Box
Paul A. Robert, Supervisor's Circle
A. T. Zingelman, Section Briefs
L. S. Eichelberger, ASQC News

Contents

ARTICLES

ASQC Standard A2-1957: Definitions and Symbols for Acceptance Sampling by Attributes 5

Moving Trend Control Charts
Donald W. Behnken 7

The moving trend control chart is discussed as a means of controlling laboratory materials tests where the measured property of the standard changes gradually (usually a decline) with respect to the time. Methods are discussed for calculating the central line and control limits for linear trends. A tabulation method is presented for determining control limits for processes whose trends are non-linear.

Latent Reliability: An Approximation Method
W. R. Davision 11

Latent reliability is a numerical score describing the degree of agreement between actual and predicted performance of an item. The method is designed solely for product development situations where costly units are destroyed by testing. The latent reliability score equates the polled percent accuracy of performance forecasts on units a, b, c, . . . k to the expected performance of the $(k + 1)^{st}$ unit.

The Control of Magnesium Alloy Castings
Chester Gadzinski and Richard W. Hooley 14

A method is presented for developing a quantitative measure of the concentration and seriousness of magnesium casting defects as revealed by x-ray examination. Also presented is a significance test for relating the values of this test measure obtained by both the vendor and consumer on the same lots of castings.

DEPARTMENTS

From the President's Desk, *General Technical Council* 4
Supervisor's Circle 19
Twelfth Annual Convention 20-21
What's New? 24
Our Ever-Growing Family 32
Section Briefs 32
Section Calendar 36
Clinics, Conferences, and Courses 38
Book Reviews 39
Product Education Service 39
Positions Wanted 39
Positions Available 39, 40
Consulting Services 40

Industrial Quality Control is published monthly by the American Society for Quality Control, Inc. Entered as second-class matter on Sept. 18, 1950 at the post office at Milwaukee, Wis.

Industrial Quality Control is sent to all members of the Society as one of the privileges of membership; yearly subscription is $3.00 of the membership dues. Subscriptions from non-members are not accepted. Subscriptions for company, public, and university libraries are: 1 yr.—$9.00; 2 yrs.—$17.00; 3 yrs.—$25.00; 5 yrs.—$40.00. Back issues of Vols. I-X are available at $6.00 per volume including index; Vol. XI, $9.00; Vol. XII-XIII, $10.00 ea. Individual copies are $1.00 each. Microfilm editions by volume of Vols. VIII-XII are also available. The cost per volume is VIII, $1.50; IX, X, $1.60 ea.; XI, $1.70; XII, $1.85.

Orders for library subscriptions, back issues, and microfilm editions should be accompanied by remittance made payable to the American Society for Quality Control, Inc. *Orders under $3.00 must be accompanied by remittance.*

Neither this magazine nor any portion of it may be copied or otherwise reproduced without written permission of the copyright owner. Requests for copyright release should be addressed to the editor, Mason E. Wescott. The statements and opinions given in the articles and papers in *Industrial Quality Control* are the views of the authors and are not necessarily those of the Society.

Notification of address change should be sent both to the secretary of your section and to the Executive Secretary's office. Allow approximately seven weeks for the change to become effective.

Executive Secretary and Publications office: Rm. 6197 Plankinton Bldg., 161 West Wisconsin Avenue, Milwaukee 3, Wisconsin. Society's New York Address: Rm. 965, 463 West St., New York 14, N. Y. West Coast advertising representative: J. E. Munford Co., 517 N. Avenue 64, Los Angeles 42, Calif., and 681 Market St., San Francisco 5, Calif.

Address all correspondence to American Society for Quality Control, Inc., Rm. 6197 Plankinton Bldg., 161 West Wisconsin Ave., Milwaukee 3, Wisconsin.

Copyright 1957
American Society for Quality Control, Inc.
Printed in U.S.A. All rights reserved

From the President's Desk

General Technical Council

For the past few years the Chairmen of Divisions and Technical Committees have met for breakfast and their annual meeting at the Annual Convention of the Society. At the meeting in Detroit, May 1957, it was suggested that there should be an opportunity to exchange information with similar groups interested in the technical activities of the Society as well as those committees concerned with the professional development of our Society. It was also suggested that this group be known as the General Technical Council. This suggestion was presented at the Operating and Executive Meeting in Detroit. Although no formal action was taken, the group was encouraged to meet two or three times during the current fiscal year to explore further possible areas of mutual interest.

The first meeting was held on August 9 in New York City. Invitations were extended to all Chairmen and Past-Chairmen of the six Divisions, the four Technical Committees (Manufacturing and Assembly, Vendor-Vendee, Foods and Allied Industries, and Metals Technical), and of the Professional Committees (Applied Methology, Education and Training, Program and Speakers, Conferences, Operations Research, Standards, and Relations with Professional Societies).

This all day meeting was held at the American Iron and Steel Institute in New York City. A very worthwhile discussion of activities and accomplishments of each committee was presented by the Chairman of each committee and discussions of the needs in the areas where activities should be shared with other committees and divisions were held.

Clarence Burdick, Vice-President with cognizance over Divisions and Technical Committees, presided jointly with Ellis Ott, Vice-President in charge of Professional Committees.

A second meeting of the General Technical Council was held in Ann Arbor, Michigan at the Michigan Union, University of Michigan, November 14.

The objectives of this General Technical Council Committee are:

1. To increase the services of our Society to its members.
2. To give more coordination and guidance to the Technical and Professional Committees and the Divisions.
3. To consider the quality and quantity of Convention papers.
4. To assist in the establishment of Conference and Division meeting dates.
5. To establish plans and control of publication of quality control papers in places other than *Industrial Quality Control.*

Sincerely,

Leon Bass

EDITORIAL NOTE

Herewith is the final draft of the Proposed ASQC Standard A2. A preliminary proposed draft submitted by the Standards Committee was published as Part III of the June 1955 issue of *Industrial Quality Control*.

The present draft incorporates revisions subsequently made in the first proposed standard. In its present form it was approved and accepted for issuance by the Board of Directors of ASQC at its meeting in Detroit, May 1957. It will subsequently be issued as a separate, bound publication of ASQC as was done with ASQC Standard A1 in 1951.

Members of the Standards Committee which prepared this standard are:

Irving W. Burr, Purdue University
W. Edwards Deming, New York University
Harold F. Dodge, Bell Telephone Laboratories, Inc. (Chairman)
Eugene L. Grant, Stanford University
Ralph E. Wareham, Consultant in Quality Control

ASQC STANDARD A2-1957

Definitions and Symbols for Acceptance Sampling by Attributes

The following definitions relate particularly to one of the most common uses of acceptance sampling, namely acceptance inspection of individual lots of a product comprising individual units. The general intent of the definitions, however, should be considered applicable also to the inspection of bulk material, to the acceptance or rejection of a process on the basis of sampling results, etc. The alternative to acceptance is termed "rejection" for the purposes of definition, although, in practice, the alternative may take some form other than outright rejection.

TERM	SYMBOL	DEFINITION
1. GENERAL TERMS RELATING TO ACCEPTANCE SAMPLING		
Acceptance Sampling		The art or science that deals with procedures by which decisions to accept or reject lots or processes are based on the results of examining samples.
Acceptance Sampling Plan		A specific plan which states (a) the sample sizes, and (b) the criteria for acceptance, rejection, or taking another sample.
Inspection Lot		A specific quantity of similar material, or a collection of similar units, offered for inspection and acceptance at one time.
Lot Size	N	The number of units in the lot.
Sample		A portion of material or a group of units, taken from a lot, the inspection of which provides information for reaching a decision regarding acceptance.
Sample Size	n	The number of units in the sample.
Single Sampling		Sampling inspection in which the decision to accept or to reject is based on the inspection of a single sample.
Double Sampling		Sampling inspection in which the inspection of the first sample leads to a decision to accept, to reject, or to take a second sample; and the inspection of a second sample, when required, then leads to a decision to accept or to reject.
Multiple Sampling		Sampling inspection in which, after each sample is inspected, the decision is made to accept, to reject, or to take another sample; but in which there is a prescribed maximum number of samples, after which a decision to accept or to reject must be reached. *NOTE: Multiple sampling as defined here has sometimes been called "sequential sampling" or "truncated sequential sampling." The term "multiple sampling" is preferred.*
Sequential Sampling		Sampling inspection in which, after each unit is inspected, the decision is made to accept, to reject, or to inspect another unit.

TERM	SYMBOL	DEFINITION
Curtailed Inspection		Sampling inspection in which, as soon as a decision is certain, the inspection of the sample is stopped. Thus, as soon as the rejection number for defectives is reached, the decision is certain and no further inspection is necessary. *NOTE: Commonly a first sample is completed for the purpose of estimating the process average.*
Normal Inspection		Inspection in accordance with a sampling plan that is used under ordinary circumstances.
Reduced Inspection		Inspection in accordance with a sampling plan requiring smaller sample sizes than those used in normal inspection. Reduced inspection is used in some inspection systems as an economy measure when the level of submitted quality is much better than that normally expected.
Tightened Inspection		Inspection in accordance with a sampling plan that has more strict acceptance criteria than normal inspection. Tightened inspection is used in some inspection systems as a protective measure when the level of submitted quality is much poorer than that normally expected.
Process Average Quality		Expected quality of product from a given process, usually estimated from first sample inspection results of past lots.
Acceptable Quality Level	AQL	The maximum percent defective (or the maximum number of defects per 100 units) which can be considered satisfactory as a process average.
Probability of Acceptance	P_a	Probability that a lot or process will be accepted.
Operating Characteristic Curve for Acceptance Sampling Plan	OC Curve	A curve showing the relation between the probability of acceptance and either lot quality or process quality, whichever is applicable.
Consumer's Risk		The probability or risk of accepting a lot, for a given relatively poor lot quality or relatively poor process quality, whichever is applicable.
Producer's Risk		The probability or risk of rejecting a lot, for a given relatively good lot quality or relatively good process quality, whichever is applicable.
Average Sample Number	ASN	The average number of sample units inspected per lot in reaching a decision to accept or to reject.
Average Total Inspection	ATI	The average number of units inspected per lot including all units in rejected lots (applicable when the procedure calls for 100 percent inspection of rejected lots).
2. TERMS RELATING TO ATTRIBUTES SAMPLING PLANS		
Acceptance Number	Ac	The largest number of defectives (or defects) in the sample or samples under consideration that will permit the acceptance of the inspection lot.
Rejection Number	Re	The smallest number of defectives (or defects) in the sample or samples under consideration that will require the rejection of the inspection lot.
Average Outgoing Quality	AOQ	The average quality of outgoing product including all rejected lots after they have been 100 percent inspected (applicable when procedure calls for 100 percent inspection of rejected lots).
Average Outgoing Quality Limit	AOQL	The maximum of the AOQ's for all possible incoming qualities, for a given acceptance sampling plan.
	p_{95}, p_{50}, p_{10}, p_{05}, etc.	Lot quality or process quality for which the probability of acceptance is 0.95, 0.50, 0.10, 0.05, etc. respectively for a given acceptance sampling plan.

NOTE: Of the entries in the second column, only N, n, P_a, p_{95}, p_{50}, p_{10}, and p_{05} are intended as mathematical symbols. All other entries are abbreviations.

NOTE ON THE MEANING OF "AQL"

When a consumer designates some specific value of AQL for a certain characteristic or group of characteristics, he indicates to the supplier that his (the consumer's) acceptance sampling plan will accept the great majority of the lots that the supplier submits, provided the process average level of percent defective in these lots be no greater than the designated value of AQL. Thus the AQL is a designated value of percent defective (or of defects per 100 units) that the consumer indicates will be accepted most of the time by the acceptance sampling procedure to be used.

The specification of AQL alone does not describe the protection to the consumer. It is necessary to refer to the AOQL of the sampling plan that the consumer will use, or to the operating characteristic curve of the plan, to determine what protection the consumer will have.

Moving Trend Control Charts

DONALD W. BEHNKEN

*E. I. DuPont de Nemours & Company**

Introduction

Control charts are often used in laboratory work in conjunction with a standard material to maintain control over test level and reproducibility. When the standard is a stable material the conventional control charts for averages and ranges of multiple determinations can be used. Usually two or more of the known samples or controls are tested along with the routine unknown material each day and the results plotted. Control averages above or below 2-σ limits will indicate the need to investigate equipment for level shifts and ranges out of limits may point out operator laxity or equipment in poor repair.

Quite often however, a more complex problem is encountered. The material being tested may not have a stable aging characteristic. The measured property may decline gradually with time, making it impossible to establish a control chart with the conventional horizontal control limits. Moreover, this aging pattern may vary sufficiently from standard to standard so that we are unable to establish an average normal aging curve from past data. If this were not true, deviations around this average curve could be used to compute a standard deviation and limits could be established in the conventional way.

Where the variability introduced by differences in aging behavior from standard to standard is sufficiently large in comparison with the test error, the use of an average curve will result in excessively wide control limits. The control chart in this case loses utility as it becomes a relatively insensitive tool for detecting significant changes in test behavior.

Moving Trend Approach

In order to provide a workable objective check on test procedures where we encounter this situation, one approach is to compute a moving trend line by least squares methods. In this way we can obtain a "best estimate" of the trend line for each standard based on current data and, using least squares theory, we can compute objective limits around the line which can be used for control chart purposes. These limits must include not only an allowance for the experimental error of the laboratory test but an additional component introduced by the estimation of a predicted value for each day from a regression line. One point to be weighed in selecting a moving trend function must be the magnitude of this additional error component.

*Mr. Behnken has left DuPont and is currently doing graduate work at North Carolina State College.

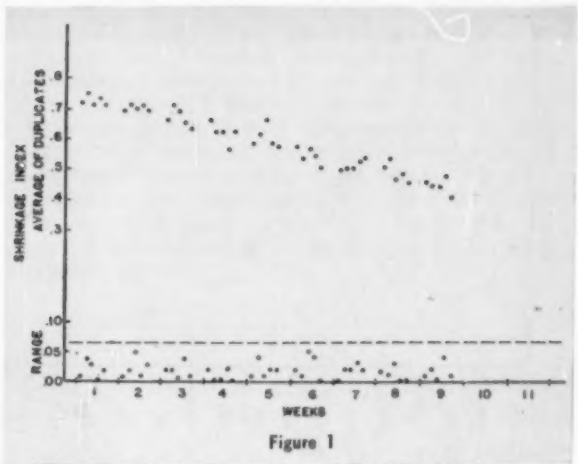


Figure 1

Figure 1 illustrates a case in which shrinkage tests were being run five days a week but where the supply of homogeneous material used as a control showed a slowly declining propensity to shrink. This trend is indicated by the plotted averages of duplicate control samples run each day. Desiring to keep calculations to a minimum, an attempt was made to find a trend line which could be calculated at the start of each week and could then be used for controlling the test for the succeeding five days. As the decline in shrinkage was essentially linear over a period of several weeks, a simple linear regression line was fitted to the data of the previous two weeks and extrapolated forward for the succeeding week. After calculating limits, this procedure was used during the life of the control as shown in Fig. 2. An effective control chart resulted for maintaining a reliable laboratory test.

Calculations were originally based on a one week moving trend line in which the trend for one week's data was extended forward to the following week. In this case, however, a seven day extrapolation resulted in control limits which were too wide. Since the assumption of linearity is justified for a three week period, a linear regression based on two weeks' data and extrapolated to predict the third weeks' behavior has appreciably greater precision. The reduced variance of the prediction leads to considerably narrower control limits and hence a more sensitive or powerful control procedure.

Depending upon the requirements of the situation, curvature may be introduced into the trend line by adding additional terms to the regression model and any desired time span may be used as the data period. In some instances the rate of change of decline may be

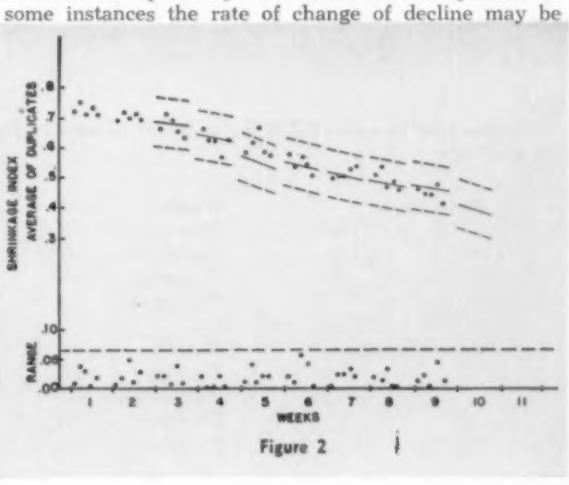


Figure 2

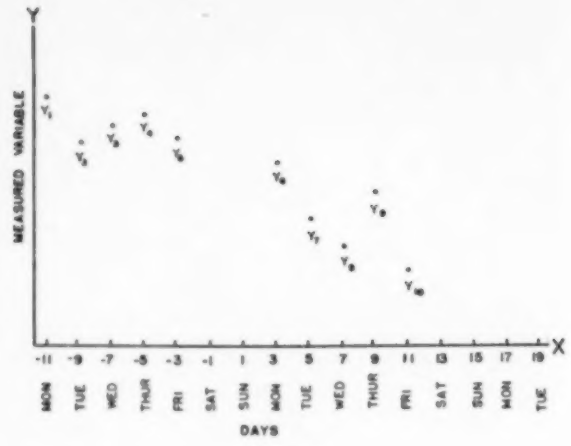


Figure 3

such that a daily revision of limits will be required to maintain limits at a sensitive level. Use of the computational procedures outlined below to compare a few alternative approaches will quickly point out a workable set of conditions.

Calculation of Trend Line

Since control samples are usually run at regularly spaced intervals in time, it is possible to take advantage of this symmetry to simplify calculations. The situation encountered in Fig. 2 is displayed in general form in Fig. 3. The individual test results are denoted by y_i's and the corresponding coded abscissa values by x_i's. The x coordinates are coded to simplest form such that $\Sigma\, x_i = 0$ and each x_i is the smallest whole integer possible.

If, as in the example above, we desire to fit a straight line of the form $y = b_0 + b_1 x$ to the data we will use least squares estimates of the coefficients. In the general case, where there are N values, the constants are determined as follows:

$$b_0 = \frac{\sum_{i=1}^{N} y_i}{N} = \bar{y} \qquad (1)$$

$$b_1 = \frac{\sum_{i=1}^{N} x_i y_i}{\sum_{i=1}^{N} x_i^2} \qquad (2)$$

In the specific case of Fig. 3 the coded values for the x scale are:

First week	Monday	−11
	Tuesday	−9
	Wednesday	−7
	Thursday	−5
	Friday	−3
Second week	Monday	+3
	Tuesday	+5
	Wednesday	+7
	Thursday	+9
	Friday	+11

We can therefore write equations (1) and (2) in the form:

$$b_0 = \frac{1}{10}[y_1 + y_2 + y_3 + y_4 + y_5 + y_6 + y_7 + y_8 + y_9 + y_{10}]$$

$$b_1 = \frac{1}{570}[11(y_{10}-y_1) + 9(y_9-y_2) + 7(y_8-y_3) + 5(y_7-y_4) + 3(y_6-y_5)]$$

In order to locate this trend for the third weeks' control chart it is necessary to calculate two points. Since this is to be a repetitive operation performed each Monday, our criterion for selecting points becomes the ease with which they can be calculated. Two of the simplest points to obtain are:

(1) The midpoint between the two weeks ($x = 0$)
$\hat{y} = b_0 = \bar{y}$

(2) The Tuesday of the third week ($x = 19$)
$\hat{y} = b_0 + b_1\ (19)$

$$= \bar{y} + \frac{1}{30}[11(y_{10}-y_1) + 9(y_9-y_2) + 7(y_8-y_3) + 5(y_7-y_4) + 3(y_6-y_5)]$$

Using the data plotted in Fig. 1 for a numerical example, we will calculate the two values needed for the fifth weeks' trend line from the data of the third and fourth week.

(1) Midpoint between the two weeks

$$\hat{y} = \bar{y} = \frac{1}{10}[0.66 + 0.71 + 0.69 + 0.65 + 0.63 + 0.66 + 0.61 + 0.61 + 0.56 + 0.62]$$
$$= 0.64$$

(2) Tuesday of the fifth week

$$\hat{y} = 0.64 + \frac{1}{30}[11(-0.04) + 9(-0.15) + 7(-0.08) + 5(-0.04) + 3(0.03)]$$
$$= 0.64 - 0.08 = 0.56$$

The trend line for the fifth week was therefore determined by these two points.

Should the problem of missing data arise, the estimated value for the day can be substituted for the y_i required in the computation of subsequent trend lines. Out-of-control points should also be handled in this way, once the assignable cause has been located and corrected. Such a procedure changes the precision of the subsequent two-weeks' regression lines. However, if the number of missing points is small, the computations to estimate the proper control limits are not warranted.

Calculation of Limits

In calculating limits for a standard control chart it is assumed that the mean value of the system is known. The limits are, therefore, a function of only the variance of future observations about this known parameter. When using a moving trend approach, however, the limits must also take into account the variance of the estimated trend values about their true value. The deviation of an observation from the regression line is a function of both the variability of the observation and this lack of certainty introduced by the use of a regression line. Assuming we are able to estimate the former by a controlled experiment and analysis of variance techniques

we can estimate the latter from the following relationship:

$$V(\hat{y}) = V(b_0) + x^2 V(b_1)$$

$$= \frac{s^2(y)}{n}\left[\frac{1}{N} + \frac{x^2}{\Sigma x_i^2}\right]$$

Where: $s(y)$ = the test error of an individual determination.

n = the number of control results averaged for each day's y_i.

$V(b_0)$ and $V(b_1)$ = the variances of the estimated coefficients.

Thus, for our illustrative example where a previous experiment had determined that $s^2(y) = 0.0018$

$$V(\hat{y}) = \frac{0.0018}{2}\left[\frac{1}{10} + \frac{x^2}{570}\right]$$

Ideally the control limits should be made wider as the week progresses since $V(\hat{y})$ is a function of the distance we extrapolate from the data which determined the trend line. In practice, however, this increase may be small and can then be safely ignored. As this will not always be true however it is essential to check this point by calculating $V(\hat{y})$ for the start and end of the week.

Computing these variances for our example:

Monday: $x = 17$ $V(\hat{y}) = 0.0009$ [0.61]

Friday: $x = 25$ $V(\hat{y}) = 0.0009$ [1.20]

Error of an estimated value $= s(\hat{y}) = \sqrt{V(\hat{y})}$

Monday: $s(\hat{y}) = \sqrt{0.0009 \times 0.61} = 0.023$

Friday: $s(\hat{y}) = \sqrt{0.0009 \times 1.20} = 0.033$

Adding the two components of variance to get the variance of a difference between the estimated trend value and an observed test result we have

$$s^2(y-\hat{y}) = \frac{s^2(y)}{n} + s^2(\hat{y})$$

Ninety-five percent confidence limits for the control chart follow then as

$$\hat{y} \pm t_{0.05}\,[s(y-\hat{y})]$$

where $t_{0.05}$ is the appropriate value from the t table depending upon the number of degrees of freedom in the estimate of $s(y)$.

Monday Limits: $\hat{y} \pm 2.03\sqrt{(0.03)^2 + (0.023)^2} = \hat{y} \pm 0.076$

Friday Limits: $\hat{y} \pm 2.03\sqrt{(0.03)^2 + (0.033)^2} = \hat{y} \pm 0.090$

It is a matter of judgment whether to use the expanding limits which could be calculated for each day or to use an average value for the week. In the case discussed above, a conservative average of ± 0.08 was used resulting in decreasing confidence probabilities but simplifying procedures for laboratory personnel. For each week's control chart, therefore, it is only necessary to calculate and plot the two points, draw the trend line for the coming week, and add the parallel upper and lower control limits 0.08 units above and below the line.

Let us now investigate the reasons for selecting a moving trend based on two weeks' data rather than one, in the light of the control limits obtained in each case.

For a one week trend our x_i's would become −2, −1, 0, 1 and 2. Substituting in the formula for the variance of an estimated value

$$V(\hat{y}) = \frac{0.0018}{2}\left[\frac{1}{5} + \frac{x^2}{10}\right]$$

Computing the error of estimated values for the following week

Monday: $x = 5$ $s(\hat{y}) = 0.03\sqrt{0.2 + 2.5} = 0.049$

Friday: $x = 9$ $s(\hat{y}) = 0.03\sqrt{0.2 + 8.1} = 0.086$

Computing 95 percent confidence control limits

Monday Limits: $\hat{y} \pm 2.03\sqrt{(0.03)^2 + (0.049)^2} = \hat{y} \pm 0.116$

Friday Limits: $\hat{y} \pm 2.03\sqrt{(0.03)^2 + (0.086)^2} = \hat{y} \pm 0.185$

Control limits are therefore increased excessively by the use of this trend line. By Friday the limits are three times the magnitude of the error stemming from the test itself and the control chart loses power in detecting changes in test level. For the two week trend line described above, a much more attractive balance was obtained between the two components of error.

Non-Linear Trends

In some instances the assumption of a linear trend will not be realistic. The same general approach can be taken if a quadratic model is used for the regression equation.

$$\hat{y} = b_0 + b_1 x + b_{11} x^2$$

Then, if as before, the time scale values are coded so that $\Sigma x_i = 0$, as a result of symmetrically spaced data we have

$$b_0 = \frac{\Sigma y_i \Sigma x_i^4 - \Sigma x_i^2 \Sigma x_i^2 y_i}{N\Sigma x_i^4 - (\Sigma x_i^2)^2}$$

$$b_1 = \frac{\Sigma x_i y_i}{\Sigma x_i^2}$$

$$b_{11} = \frac{N\Sigma x_i^2 y_i - \Sigma y_i \Sigma x_i^2}{N\Sigma x_i^4 - (\Sigma x_i^2)^2}$$

Also

$$V(\hat{y}) = V(b_0) + x^2 V(b_1) + x^4 V(b_{11}) + x^2\, 2\, \mathrm{Cov}(b_0 b_{11})$$

$$= \frac{s^2(y)}{n}\left[c_{11} + x^2 c_{22} + x^4 c_{33} + x^2 2c_{13}\right]$$

where

$$c_{11} = \frac{\Sigma x_i^4}{N\Sigma x_i^4 - (\Sigma x_i^2)^2}$$

$$c_{22} = \frac{1}{\Sigma x_i^2}$$

$$c_{33} = \frac{N}{N\Sigma x_i^4 - (\Sigma x_i^2)^2}$$

$$c_{13} = \frac{-\Sigma x_i^2}{N\Sigma x_i^4 - (\Sigma x_i^2)^2}$$

Tabular Procedure for Non-Linear Trends

In cases where equations of second degree and higher must be used it may be more convenient to omit the graphical approach and merely check test results against calculated limits. A simple procedure can be followed which is most easily outlined in terms of matrix notation and which will summarize the general approach for any regression model.

The coded values of the time scale are denoted by an m by (k+1) matrix X, where m is the number of days used to estimate the regression line and k is the degree of the polynomial. Using as an illustration the quadratic model for the situation discussed above, where two weeks' data are used to predict the third weeks' behavior, we have

$$X = \begin{bmatrix} 1 & x_1 & x_1^2 \\ 1 & x_2 & x_2^2 \\ 1 & x_3 & x_3^2 \\ 1 & x_4 & x_4^2 \\ 1 & x_5 & x_5^2 \\ 1 & x_6 & x_6^2 \\ 1 & x_7 & x_7^2 \\ 1 & x_8 & x_8^2 \\ 1 & x_9 & x_9^2 \\ 1 & x_{10} & x_{10}^2 \end{bmatrix} = \begin{bmatrix} 1 & -11 & 121 \\ 1 & -9 & 81 \\ 1 & -7 & 49 \\ 1 & -5 & 25 \\ 1 & -3 & 9 \\ 1 & 3 & 9 \\ 1 & 5 & 25 \\ 1 & 7 & 49 \\ 1 & 9 & 81 \\ 1 & 11 & 121 \end{bmatrix}$$

The ten test results for these days are represented by the column vector

$$Y = \text{col } [y_1\ y_2\ y_3\ y_4\ y_5\ y_6\ y_7\ y_8\ y_9\ y_{10}]$$

and the estimated coefficients by

$$B = \text{col } [b_0\ b_1\ b_{11}]$$

The extrapolated coded time scale values for the third week are denoted by

$$X^* = \begin{bmatrix} 1 & x_{11} & x_{11}^2 \\ 1 & x_{12} & x_{12}^2 \\ 1 & x_{13} & x_{13}^2 \\ 1 & x_{14} & x_{14}^2 \\ 1 & x_{15} & x_{15}^2 \end{bmatrix} = \begin{bmatrix} 1 & 17 & 289 \\ 1 & 19 & 361 \\ 1 & 21 & 441 \\ 1 & 23 & 529 \\ 1 & 25 & 625 \end{bmatrix}$$

Estimating the regression coefficients by least squares we have

$$B = [X'X]^{-1}X'Y.$$

The estimated values for the third week can then be easily obtained by the following matrix multiplication:

$$\hat{Y} = X^*B$$
$$= X^*\ [X'X]^{-1}X'Y$$
$$= AY$$

where

$$\hat{Y} = \text{col } (\hat{y}_{11}\ \hat{y}_{12}\ \hat{y}_{13}\ \hat{y}_{14}\ \hat{y}_{15}) \text{ and}$$

$$A = X^*\ [X'X]^{-1}X'$$

The matrix A need be calculated but once for each system and can then be used each week to find the predicted values.

For our example the transpose of A is shown below:

$$A' = \begin{bmatrix} 0.69258 & 0.93967 & 1.21862 & 1.52918 & 1.87161 \\ 0.17683 & 0.25238 & 0.33990 & 0.43925 & 0.55057 \\ -0.22384 & -0.28413 & -0.34833 & -0.41657 & -0.48871 \\ -0.50943 & -0.66984 & -0.84609 & -1.03825 & -1.24625 \\ -0.67994 & -0.90475 & -1.15337 & -1.42580 & -1.72203 \\ -0.50099 & -0.70476 & -0.93231 & -1.18370 & -1.45887 \\ -0.21118 & -0.33651 & -0.47767 & -0.63474 & -0.80765 \\ 0.19371 & 0.18254 & 0.16745 & 0.14835 & 0.12533 \\ 0.71368 & 0.85237 & 1.00306 & 1.16556 & 1.34005 \\ 1.34873 & 1.67300 & 2.02914 & 2.41691 & 2.83653 \end{bmatrix}$$

The variance of the predicted values for the third week can be obtained by multiplying the test variance by the diagonal elements (d_i) of the matrix

$$AA' = X^*\ (X'X)^{-1}\ X^{*\prime}.$$

In this case AA' is a 5 × 5 matrix and we shall use a subscript notation for its diagonal elements corresponding to the appropriate y_i's such that

$$V(\hat{y}_{11}) = \frac{s^2(y)d_{11}}{n},$$

where

d_{11} is the first diagonal element of AA',

$s^2(y)$ is the test variance as estimated from previous data, and

n is the number of determinations averaged to obtain each y_i.

Since we need the variance of the deviations from the regression line, however, we must as before use the estimate

$$V\ (y_i - \hat{y}_i) = \frac{s^2(y)}{n} + \frac{s^2(y)d_i}{n}$$
$$= \frac{s^2(y)}{n}\ (1 + d_i)$$

This calculation also need only be made once for each system since it is independent of the observed values.

Completing these basic calculations for our illustrative example

$$AA' = \begin{bmatrix} 3.94440 & & & & \\ & 6.46335 & & & \\ & & 10.01698 & & \\ & & & 14.84173 & \\ & & & & 21.20144 \end{bmatrix}$$

and the control limits can be determined as shown in the following table:

i	Third Week	V $(y_i - \hat{y}_i)$	95% Confidence Limits
11	Monday	$\frac{s^2(y)}{n}(1 + 3.944)$	$\pm t_{0.05}\frac{s(y)}{\sqrt{n}}$ (2.22)
12	Tuesday	$\frac{s^2(y)}{n}(1 + 6.463)$	$\pm t_{0.05}\frac{s(y)}{\sqrt{n}}$ (2.73)
13	Wednesday	$\frac{s^2(y)}{n}(1 + 10.170)$	$\pm t_{0.05}\frac{s(y)}{\sqrt{n}}$ (3.34)
14	Thursday	$\frac{s^2(y)}{n}(1 + 14.842)$	$\pm t_{0.05}\frac{s(y)}{\sqrt{n}}$ (3.98)
15	Friday	$\frac{s^2(y)}{n}(1 + 21.201)$	$\pm t_{0.05}\frac{s(y)}{\sqrt{n}}$ (4.71)

Each day then the difference between the observed value and the estimated value $(y_i - \hat{y}_i)$ can be compared with the appropriate confidence limits to provide an objective check on the test procedure. The appropriate t_a value is chosen from the t-Table depending upon the confidence level desired and upon the degrees of freedom involved in the calculation of s(y).

The illustrative example chosen here illustrates a difficulty encountered in using non-linear trends. In the table above it is apparent that, in extrapolating to Friday of the third week, rather wide confidence limits are obtained. When quadratic trends are required it is usually necessary to compute the trend more frequently or to use a longer base period. In either case the relative degree of extrapolation is decreased resulting in a more powerful control procedure.

Summary

The moving trend approach can be used either in conjunction with control charts or through a direct comparison with calculated limits. In either case, calculation of the confidence limits and the derivation of a simple computational formula for obtaining the extrapolated values are one-time propositions for each system. The system itself is contingent upon the following three factors:

1. The type of trend used
2. The length of the base period used for fitting the trend
3. The frequency with which the projected trend is to be revised

The only routine calculation then required is the periodic substitution in the extrapolation formula to obtain the estimated values about which the limits are placed.

Acknowledgment

The author gratefully acknowledges the assistance given him by Dr. S. L. Andersen through his valuable suggestions for improving the original version of this article.

Latent Reliability
An Approximation Method

W. R. DAVISON

Phillips Petroleum Company, Bartlesville, Okla.

Abstract

"Latent Reliability" is a score describing the agreement between engineering predictions of end-item performance and actual performance. The method is designed solely for product development situations where costly units are destroyed by testing. The Latent Reliability score equates the pooled percent accuracy of performance forecasts on units a, b, c, . . . k to the expected performance on the $(k + 1)^{th}$ unit. Since there is no inherent requirement for extensive replication, the approach lends itself to experimental work where each test may result in design or process changes affecting the next test unit. Both the underlying rationale and the stepwise method of computation are presented.

Introduction

Reliability is the probability that any unit of product will work as the designer intended. Several mathematical models such as the Poisson and the Binomial are available for computing a probability-oriented estimate of reliability, but they require data which can be obtained only by extensive testing. Practical difficulties arise where performance tests destroy product of high unit value. Under certain conditions the Binomial calls for 3,000 or more tests; a less powerful approximation (such as one of the asymptotic functions discussed in the literature of mathematical statistics) might require as few as 300 tests. But when each test may cost $10,000 or more, even 300 is a prohibitive number.

This article introduces the latent reliability concept, an approach designed for product development situations where costly units are destroyed by testing. "Latent reliability" describes the agreement observed between engineering predictions of performance and actual

performance, with respect to selected functioning characteristics. In essence, this concept equates the pooled percent accuracy of performance forecasts on units a, b, c, . . . k, to the expected performance of the $(k + 1)^{th}$ unit. Since there is no inherent requirement for repeated trials of one design/process combination, the latent reliability approach lends itself particularly well to experimental work where each test may lead to design or process changes affecting the next test unit.

Discussion

Military contracts covering development work on rocket motors generally contain a provision requiring the contractor to submit an estimate of end-item reliability prior to final qualification testing of the new rocket. The problem posed by this requirement differs from contract to contract depending upon factors such as the desired completion date, the size of the budget, and the scope of work to be done.

The typical rocket development project operates within fixed limits of time and money, often at a "crash program" tempo. If the unit undergoing development is a big one, the project engineer may be required to accomplish the transition from blueprint to blue yonder on the basis of 15 or 20 experimental firings. There is neither time nor cash to assemble and test several examples of each design. Not only do test models differ design-wise from each other but also the unit built for qualification (to which the reliability estimate must refer) may be several times larger than any model previously tested.

Reliability estimation boils down to "knowing," in the statistical sense, how a particular component is going to perform when subjected to test. This special knowledge is acquired by accumulating performance results until sufficient data are at hand to support a statement such as: "There is less than 1 chance in 20 that the reliability of this product is below 0.98."

Probability-oriented estimates of reliability are available only through extensive testing performed either upon components, end-items, or both. Occasionally we find statements in the literature which leave the reader free to infer that reliability is a synonym for quality. Industrial experience runs counter to this belief. Quality, in the industrial sense, refers to compliance with applicable drawings and specifications, a condition notoriously independent of product performance. Countless engineering change orders have been and will continue to be initiated because parts made in conformance to the drawings failed to function satisfactorily in service. Furthermore, there is abundant evidence that an immature design or an excessively tight set of tolerances may produce a situation wherein nonconforming parts are found to work at least as well as those which meet specification requirements.

When product emanating from a given design/process combination is contaminated by the presence of a few unreliable units—say less than one percent—it is often difficult to discover that fact by sampling. The preponderance of good material makes it easy to draw a random sample comprised entirely of good pieces. Now if high reliability is urgently desired and if the performance test is non-destructive, bad pieces can be screened out of the lot by 100 percent testing. Where the test is destructive, however, economic restrictions limit the amount of testing and hence the amount of information available for reliability estimation. An impasse develops wherein the largest sample one can afford may be too small to detect the existence of material which cannot be tolerated. There is no escaping the fact that more information about reliability is gained from a single failure than from a hundred successes.

Where an optimum design and an optimum process can be assumed, end-item reliability may also be estimated from the individual component reliabilities. Suppose, for example, that the end-item is a simple assembly of three major components, and suppose it is known that the reliability of Component A is 0.99, the reliability of B is 0.94, and that of C is 0.96. Reliability of the end-item would then be (0.99) (0.94) (0.96) $\cong$ 0.89, which illustrates the further point that nearly perfect components are needed to achieve a moderately reliable product.

It is reasonable to assert that the engineer designs purposely and selectively toward an optimum which he believes will meet a given set of performance requirements. Changes may be introduced to compensate for faults revealed by static tests, but each modification is a deliberate move in the direction of a fully adequate design. As development work proceeds, the designer can forecast, within fairly close limits, what effect each modification will produce upon the various performance characteristics. If, therefore, in k trials of a given rocket type, the observed values of, say, Effective Impulse fall within some predetermined allowable range of forecast values, it can be argued that the $(k + 1)^{th}$ forecast of Effective Impulse is also likely to be verified by the observed test value.

The designer's ability to satisfy a given set of performance requirements can be measured by comparing forecast versus actual performance in successive trials of related units, and the results then imputed to the expected performance of the next unit tested. Such measurements obtained for each performance characteristic can be combined to yield a score which describes the over-all degree of agreement between predictions and observed performance. This over-all score is termed the "latent reliability" of the design.

Restrictions

The rationale of latent reliability applies to a series of units produced within the same program and should not be used to embrace a number of different projects each having its own set of design requirements or objectives. Thus it would be improper to attribute to the first unit fabricated under Project D the latent reliability achieved in connection with Project A, B, or C.

An additional restriction affects the kind of evidence which may be used for scoring purposes. To a degree, we beg the fundamental question of reliability by relating the estimate to a comparison of actual versus predicted performance, for even if the predictions are verified by test results, the observed performance may still be inadequate. In other words, it would be possible to produce an estimate of perfect latent reliability on the basis of accurately predicted failure. The procedure therefore requires *success* forecasts and assumes that the model specification (to which qualification rounds are designed and fabricated) will specify performance characteristics acceptable to the sponsoring agency or service.

Finally, it is desirable to correct for the number of tests in order that scores will tend to be conservative. The recommended correction factor, $-100\ (0.5^k)$, is applied to the pooled score as explained below. Thus the highest value possible for latent reliability estimates based upon a single test is 50; i.e., $100 - 100\ (0.5)$.

If the first test failed completely, use of the correction factor would produce a negative value of the latent reliability estimate. Negative values are therefore defined as zero.

Computation

The procedure for developing a latent reliability estimate is presented with reference to Table I, using data on the performance of a fictitious rocket. Modifications of the method shown might be required for other applications.

STEP 1. List the performance characteristics of interest. These characteristics are dictated by the design objectives of the unit undergoing development.

STEP 2. Weight each characteristic according to its importance in the particular experimental unit to be tested. The sum of weights equals 100.

STEP 3. Prior to test obtain the forecast value of each characteristic from the project engineer.

STEP 4. Complete the record by entering test results.

STEP 5. Compute p_a, the measure of relative agreement between forecast and observed values for each characteristic.

$$p_a = 1 - \frac{F_p - F_0}{F_p},$$

where F_p and F_0 are, respectively, predicted and observed values. When $F_p = F_0$, p_a takes its maximum value, i.e., $p_a = 1$. Negative values of p_a, which arise when $F_0 > 2F_p$, are treated as zero. Consideration was given to the use of penalties or negative scores in the case $F_0 > 2F_p$. This notion was abandoned because characteristics listed in Table I are not mutually independent. Large differences between forecast and observed results for one characteristic are, in the present application, reflected in comparable differences elsewhere. In other words, the penalty system is built-in, although this might not be the case in some other development situation.

STEP 6. Multiply each p_a by its corresponding weight, W.

STEP 7. Compute the raw score, $\Sigma\, p_{a_i} W_i = (p_{a_1} W_1) + (p_{a_2} W_2) + \ldots (p_{a_n} W_n)$.

STEP 8. The raw score from Step 7 can now be combined with those of earlier tests in the same series by computing the over-all average.

STEP 9. Apply the correction term, $-100(0.5^k)$, to the pooled raw score computed in Step 8. The exponent k represents the total number of tests in the series. If $k > 7$ the correction factor becomes negligible and may be omitted. The result of this step estimates latent reliability applicable to the forecast parameters of the next unit in the series to be tested.

Similarly, the latent reliability estimate for a single characteristic can be computed over units in the same or closely related series of tests. For example, if interest were centered upon Duration (see Table I), the unweighted p_a values for that variable may be pooled either by computing an arithmetic mean or by taking an over-all product and extracting the k^{th} root to obtain the geometric mean, $p_a{}^*$. (If any $p_a = 0$, the arithmetic rather than the geometric mean is used.) The correction terms -0.5^k should then be applied, since the average used is a decimal fraction.

In defining a test series, recognition is given to the progressive complexity and importance assumed by experimental test units as a development project moves toward completion. Early test sequences often involve scaled-down models, or may be devoted primarily to an investigation of one design characteristic, and are thus less important than a later sequence or test series employing large scale units. These differences, where they arise, are accounted for by assigning weights to each test series before computing the grand average latent reliability which will be attributed to the qualification test rounds.

Under the suggested procedure, the corrected latent reliability value of each series is multiplied by the corresponding series weight factor, after which the mean is obtained as outlined in Step 7. (Where the geometric mean is used, division of the over-all product by the sum of weights is performed before the k^{th} root is extracted.)

Conclusion and Summary

While the validity of using forecast versus observed performance to estimate reliability is not subject to rigorous proof, the method outlined

TABLE I—Computation of Latent Reliability

Firing: Round 3

1	2	3	4	5	6	7	8
Characteristic	Weight (W)	Predicted (F_p)	Observed (F_o)	Col 3 Minus[a] Col 4	Col 5 div. by Col 3	1 minus Col 6 (p_a)	Col 7 times Col 2
Ignition Delay (ms)	5	300	500	200	.67	.33	1.65
Duration (Tangent time)	50	90	75	15	.17	.83	41.50
Initial Pressure	3	250	240	10	.04	.96	2.88
Final Pressure	3	235	300	65	.28	.72	2.16
Maximum Pressure	5	260	520	260	1.00	-0-	-0-
Minimum Pressure	3	230	240	10	.04	.96	2.88
Average Pressure	6	250	420	170	.68	.32	1.92
Initial Thrust	3	2,980	3,420	440	.16	.84	2.52
Final Thrust	1	2,840	3,600	760	.27	.73	.73
Maximum Thrust	2	3,110	4,750	1,640	.53	.47	.94
Minimum Thrust	1	2,760	3,420	660	.24	.76	.76
Average Thrust	3	2,955	3,700	745	.25	.75	2.25
Total Impulse	4	266,000	285,000	19,000	.07	.93	3.72
Tangent Impulse	6	248,700	221,200	27,500	.11	.89	5.35
Specific Impulse	2	140	143	3	.02	.98	1.96
c*	3	3,300	3,260	40	.01	.99	2.97
Totals	100	...	...	...	...	...	74.19

Raw Scores: This round 74.19
Round 2 ..... 64.29
Round 1 ..... 66.71

[a] Absolute value

Average Raw Score = 74.19 + 64.29 + 66.71 ÷ 3 = 68.39
Correction Factor: $-100(.5^3) = -12.5$
Latent Reliability: 68.39 − 12.5 = 55.89 or 56%

above yields a meaningful and usable estimate of progress in a development program toward an adequate design/process combination. The latent reliability concept is applicable to situations wherein extensive performance testing is not feasible, but should not be considered an equivalent substitute for reliability estimates from the Binomial or other probability-oriented models.

Bibliography

1. "Evaluation of Reliability in Product Development" by Myron Lipow and Richard D. Geckler, American Rocket Society reprint; paper read at ARS Fall Meeting, 1955, Los Angeles, Calif.
2. Lusser, Robert, *Reliability of Guided Missiles*, Redstone Arsenal, Huntsville, Ala., 1954
3. Lusser, Robert, *Proposed Reliability Specifications for Guided Missiles*, Redstone Arsenal, Huntsville, Ala., 1955
4. Shewhart, W. A., *Economic Control of Manufactured Product*, D. Van Nostrand, Inc., New York, 1931
5. Gore, W. L., *Statistical Methods for Chemical Experimentation*, Interscience Publishers, Inc., New York, 1952

Acknowledgment

The author acknowledges his debt to Dr. Edwin F. Moore, Rocket Fuels Division, for valuable contributions to the scoring method and procedure discussed in this article.

The Control of Magnesium Alloy Castings

CHESTER GADZINSKI and RICHARD W. HOOLEY*

Objective

To determine an efficient economical means to control the quality of magnesium alloy castings.

Definition of Quality Control

Quality shall be considered first as physical property, i.e., strength, ductility, chemical composition, etc.; and secondly, as dimensional stability.

This article will be limited to describing control over the physical property.

Affecting the physical properties of castings are the various foundry practices. These we shall consider primary influences subject to primary control. Destructive testing, proof load testing, chemical analysis, etc., are secondary controls used to measure the effectiveness of the primary control.

Discussion will be limited to secondary controls.

In summary, we shall discuss secondary controls over the physical properties of magnesium alloy castings.

Various Methods for Secondary Control of Casting Quality

The methods for the secondary control of casting quality can be classified into two main categories, namely, direct and indirect.

Indirect Methods of Control

- **Chemical Analysis**
  The purpose of chemical analysis is to identify the material to be that which the design engineer has specified.

- **Pouring Temperature**
  The higher the pouring temperature, the lower the mechanical properties in light metal castings. Therefore the pouring temperature becomes a control characteristic.

- **Heat Treatment**
  Magnesium alloy castings may be used as cast or in a heat treated condition. Heat treatment is not required for general use. However, when increased tensile strength, ductility, and toughness are required, without change of yield strength or hardness, castings are "solution heat treated". Heat treatment affects the grain structure of the casting and is a function of the temperature and time. By analyzing the grain structure of a test specimen, evidence that the castings have received the proper heat treat can be established.

- **Physical Results of Test Specimens**
  Test specimens are tested to destruction for the determination of yield strength, tensile strength, hardness, and ductility. It is not intended that these separately cast test specimens should be a quantitative measure of the strength of the casting since it is only rarely, and almost pure coincidence, that the casting conditions of every part and section of a commercial structure can be reproduced in test sections.[3] The assumption that the properties of a commercial casting can be represented accurately by small test bars is responsible for considerable discussion in trade circles regarding the manner of casting test coupons. It can be demonstrated readily that the tensile properties of test coupons can vary over a wide range independent of the properties of the casting, even when the coupon is attached to the casting and apparently cast under similar conditions. It is an interesting fact that even when the tensile strength of bars cut from a casting varies considerably from the tensile strength of the accompanying separately cast specimen, the corresponding yield strengths are much more nearly equal. This is an important point inasmuch as the designer usually is interested in conditions required for yielding rather than for breaking.

- **Fluorescent Penetrant Inspection**
  Fluorescent penetrant inspection is used primarily to locate cracks in non-ferrous materials. This inspection tells little or nothing of the physical properties which the casting may possess.

*Mr. Gadzinski is with the General Electric Company, Special Defense Projects, Philadelphia, Pa. Mr. Hooley is a member of the Faculty of Fordham University, New York, N. Y.

None of these methods alone or grouped together is sufficient to describe with any degree of certainty the ultimate physical properties of the castings in question. This deficiency is due primarily to the restricted area which these tests represent.

Direct Methods of Control

- *Proof Load Testing*

  In the proof-load test each casting is subjected in a specific manner to a load which bears some relation to the design stress.[3] This test has certain limitations which tend to restrict extensive use. It is applicable only in the case of well determined and simple types of loading. In most applications the service loads are so little known that it is difficult or impossible to define a proof-load which could be taken as a satisfactory measure of the ability of the casting to withstand service conditions. The expense of an elaborate set-up and the time necessary to perform the test frequently may warrant the selection of another form of quality inspection.

- *Static Breakdown Test*

  The static breakdown test, although not yielding data directly applicable to service life inasmuch as the casting tested is destroyed completely, does give valuable information regarding design and foundry technique.[3] If only one of the many tools for developing and testing aircraft castings were available, this method probably would be selected as the most valuable. The static breakdown test necessitates the construction of a fixture which will allow the loads to be applied in a suitable testing machine in the same direction as service loads. The static loads may be either tension or compression or a combination of the two forces. Deformation or strain may be measured by means of indicator or strain gages, and load deflection curves can be plotted. This procedure permits a complete survey of the casting under the applied static load, up to and including the breaking load.

- *X-Ray Examination*

  The x-ray is primarily a picture of the internal discontinuities of structure the casting may possess. Attempts at objective correlation between the type of defects that present themselves in castings as determined by x-ray technique and the resultant physical properties of the casting have proved futile.[1] Nevertheless, the x-ray in the hands of skilled foundry men can prove an invaluable tool in the improvement of casting quality.

Design Problem and Control Philosophy

This brief and somewhat cursory discussion of methods for testing and control leads to the conclusion that there is not yet available a satisfactory direct method of predicting the normal service life of a casting. The dilemma is further complicated since relatively little is known concerning the relation of defects in the microstructure, or of the breaking strength of a casting, to the endurance qualities.[3] When designers are able to state definitely the magnitudes of the vibrating stresses that occur in a particular section during service, metallurgists will be able to predict the safe sectional thickness of castings or forgings. Until the designer can determine the relation of dynamic to static stress in aircraft parts, it will be necessary to continue to compute a static stress and add an additional factor to compensate for these indeterminate stresses.

Although no one of the test and inspection techniques by itself gives satisfactory results, nevertheless, when considering the physical properties of castings, they serve, as a group, as a powerful tool which can be used to improve foundry technique. This is a change in the present philosophy, for up to this time these methods have been used primarily as a means of large scale routine control, with the improvement of the parts through correction of the defects as revealed by such control more of a secondary function.

In a brilliant paper published in the *Journal of Aeronautic Sciences* dated June 1942, Mr. B. C. Boulton of the Lockheed Aircraft Corporation describes the use of x-ray technique to improve foundry practice and he illustrates how the number of rejections increase inversely as the number of castings produced. Plotting the curve of this proportion against the percent defective on the vertical axis and the number of castings produced on the horizontal axis yields a hyperbola asymptotic to some percent defective. Realizing this, and having arrived at a point of diminishing return, we can describe sampling procedures to insure ourselves of continued product quality and thereby minimize costly quality maintenance.

Choice of Control Media

The choice of control media must be conditioned by first considering how the most information can be obtained from as few elements as possible, and how the information obtained can serve as a creative means for quality improvement and quality maintenance.

The choice of chemical analysis, coupon bar testing, and x-ray inspection best fulfills these requirements. Chemical analysis serves to identify the material to be as specified. The analysis of coupon bar specimens serves to provide a valid determinant of yield strength. X-ray inspection serves as an indicator of foundry practice and as such is ably suited to serve as the critical means for quality improvement.

For a small lot process, such as ours, the versatility of x-ray methods versus the restricted and highly specialized use of proof-load testing equipment and static breakdown testing equipment lends further argument in favor of the x-ray method.

Procedure for Administering Control

This procedure is principally to cover a customer-vendor situation. However, only a slight variation would be necessary to cover situations where the supplier and consumer were in the same organization.

The first consideration in any customer-vendor relation is the choice of vendor. The choice of vendor is conditioned by the results of an investigation whose purpose is to make sure the vendor has the facility and know-how required for the job. The importance of this investigation cannot be overemphasized.

The second consideration is the control of information which the customer sends to the vendor. Obviously this is the second most important consideration, for the foundry will not be able to begin to work properly unless it possesses *all* of the necessary information.

Further guarantee that the foundry is applying at least minimum control practices to the special processes is provided by government certification of them. The customer may then request a certified document from the vendor to the effect that these special processes are government certified. Routines to police this certification procedure are also established.

These are then the preliminary steps taken to insure the control of quality at the foundry.

To insure further control, test bar specimens are requested from the foundry as well as x-ray photographs of the castings in question.

The test bars will provide samples for chemical analysis and will serve as specimens from which yield strength can be determined. The x-ray photographs shall provide an indicator of foundry practice and properly analyzed shall serve as creative means for quality improvement.

Detailed Description of the Use of X-ray Method for the Economical Control of Casting Quality

A classification of the types of defects with a description of how they appear in an x-ray photograph follows:

• Major Defects

Major defects are those which are likely to cause casting failure due to localized stress concentration. Types of major defects are as follows:

1. *Cracks*
   (a) *Hot Cracks*—ragged dark lines, numerous branches, grouped to definite continuity.
   (b) *Cold Cracks*—straight, dark continuous lines—generally exist singly.
2. *Shrinkage*—branching, jagged, darkened areas—represent cavities due to insufficient metal.
3. *Cold Shuts*—distinct dark lines of various lengths—separations where two streams of molten metal do not form a bond.
4. *Misruns*—distinct darkened areas, smooth outlines—where metal did not fill the mold.
5. *Minor Defects*—so arranged as to cause stress concentrations—such as linear arrangements across lines of stress.

• Minor Defects

Minor defects are those which are not likely to cause casting failure due to localized stress concentration; however, these defects can cause casting rejection when present in excessive concentrations.

1. *Gas Porosity*—(hydrogen porosity)—round or elongated dark spots corresponding to minute voids—usually found in aluminum castings, spread throughout casting.
2. *Microshrinkage* — (magnesium alloy castings)—dark feathery streaks or dark irregular patches corresponding to a grain boundary shrinkage condition.
3. *Blow Holes*—(gas holes)—round or elongated smooth edge dark spots—individually, in clusters, or throughout casting.
4. *Dross Inclusions*—darkened irregular areas of various intensities—result of dross which is caught during solidification before it floats out.
5. *Sand Inclusions*—irregular gray to black patches of uneven granular texture with indistinct outline.
6. *Segregation*—in magnesium alloys it appears as a definite line with different crystalline structure and chemical analysis on each side. Usually due to different solidification rates. In aluminum alloys Cu and Fe segregates appear as irregular light patches.
7. *Mottling*—pattern of alternate light and dark areas—usually fine texture due to x-ray diffraction.

• False Indications of Defects

At times, x-ray films will indicate defective castings when actually the film is defective. If the film is of such low quality that proper evaluation of the casting is impossible, the casting must be radiographed again. Types of film defects are as follows:

1. *Secondary Radiation*—appears as dark spots or streaks (often radial) of irregular dimensions and indistinct outline. Frequently appear under thick or round sections and sections at distance from film during exposure.
2. *Developer Streaks*—light and dark parallel streaks, or elongated areas—due to exhausted developer running down film.
3. *Fixer Spot*—Yellow opaque areas of smooth outline and irregular shape—due to two films in contact during fixation.
4. *Drying Spot*—transparent spots and streaks on surface of film which may be identified when viewed by reflected light—due to uneven drying.
5. *Scratch*—readily identified by reflected light—due to carelessness.
6. *Crimp*—small, arc shaped dark areas which may be identified by reflected light—due to sharp localized bending of film.
7. *Fogging*
   (a) Dark, opaque areas—due to exposure to light or x-ray.
   (b) General graying of unexposed parts of film—due to "chemical fog" of developer.
8. *Static*—thin, dark dendritic lines, or dark gray spots with black interior—due to static electricity.
9. *Developer Stains*—Brown or iridescent markings on film surface—due to old or oxidized developer.
10. *Gassette Defects*—May be recognized by recurrence in same location on several films.
11. *Emulsion Defects*—light or dark spots, parallel lines. May be recognized by their indiscriminate location.
12. *Casting Surface Irregularities*—will correspond to irregularities on actual casting.

This description of defects is exactly as that which appears in S.I. 14326.*

Figure 1 illustrates a form which is to be used by both the vendor and customer to describe the particular area of the casting in which defects appear. The purpose of this method is to get a picture of the concentration of defects as they appear in the casting. This will serve to condition the acceptance judgment of the customer by relating the density and seriousness of the defect to the entire casting. Also, this will serve to focus attention and effort to eliminate certain defects from the highly stressed, hence critical areas. By a careful analysis of this form, what is desired and what is possible under a given set of foundry conditions, can be reconciled. It becomes apparent that this method of analysis will serve as the creative means of stimulating quality improvement.

Description of Form

The purpose of this form (Fig. 1) is to provide a graphic account of the concentration of defects in magnesium castings. This form is also used to provide data for statistical analysis. The purpose of this statistical analysis is to measure any bias of judgment that may present itself in the inspection of casting x-rays between the customer and vendor; also, this statistical analysis serves to measure any significant improvement in product quality. This analysis of significant quality maintenance or improvement in turn serves as objective evidence for reducing the amount of x-rays necessary to insure adequate control.

Figure 1 illustrates the analysis sheet for x-ray photos of magnesium

*"Radiographic Standards for Aluminum and Magnesium Sand Castings," General Electric Co., *Standing Instructions* No. 14326, Dec. 4, 1950.

ANALYSIS SHEET FOR X-RAY PHOTO'S OF MAGNESIUM ALLOY CASTINGS

DESCRIPTION _____ VENDOR _____

DRAWING NO. _____ PURCHASE ORD. NO. _____

BY _____ DATE _____

DEFECT		AREA NUMBER / CLASS								
SAND AND DROSS	ACC									
	R									
GAS POROSITY	ACC									
	R									
BLOW HOLES	ACC									
	R									
MICRO SHRINKAGE	ACC									
	R									
SHRINKAGE	ACC									
	R									
COLD SHOTS	ACC									
	R									
MOTTLING	ACC									
	R									
SEGREGATION	ACC									
	R									
CRACK	R									
NONE										

Figure 1—Analysis Sheet for X-Ray Photos of Magnesium Alloy Castings

alloy castings. There is space provided for the description of unit i.e., name of unit, such as "Yoke", "Saddle", etc.; drawing number, vendor's name, purchase order number, by whom the analysis was made, and date. Below this block there is space provided for area number. This number refers to a particular area on the casting. These numbers usually run from one to nine. Below this block there is space provided for class. The description of this class designation A, B, C, etc., will be as defined in S.I. 14326. This class designation will also appear on the drawing.

On the left hand side of the form the defects as defined above are listed. To the right of this list of defects there are columns marked ACC for acceptable and R for reject. The acceptance or rejection of a particular defect will be as defined by S.I. 1432[illegible] and any notes which may appear on a drawing.

For each casting x-ray observed one and only one judgment is entered on the form. If an area possesses more than one type of defect only the most prominent is entered on the form. If no defects appear in the area, the "None" row is marked in the appropriate column.

This form is to be used for the first 100 consecutive castings produced which have been considered fit for x-ray. This form and the x-rays accompany the castings sent by the foundry to the customer. The customer's inspector at receiving inspection fills out a similar form and records his judgments of the x-rays presented. The inspector is deprived of the benefit of seeing the results of the vendor's judgments. This is simply to avoid collusion. The recorded judgments of both the customer and the vendor are then tested for significance. If no significant difference exists between the customer's inspector and the vendor's inspector, both inspectors will become certified. If any true difference in judgment appears, a meeting between the customer and vendor is called to reconcile these differences.

Testing for Significance

The method of determining whether or not the recorded judgments differ significantly is as follows. Since in this case our (the customer's) inspector is a man of considerable experience in foundry work and consequently one whose judgment can be trusted, consider the customer's recorded judgments as ideal in the sense of being correct. If the recorded judgments of the vendor differ from those of the customer, this difference may be due to either or both of the following factors:

◇ **Chance**—one inspector might happen to see a minor defect overlooked by the other inspector. Or where there are two defects of relatively equal importance, one inspector may choose to record one and the second inspector the other.

◇ **Bias in judgment**—a persistent tendency of the vendor's inspector to record one or more defect types differently from the customer. That is to say, for the same set of pictures the vendor's inspector persistently records more (or less) entries in the defect category of (say) blow-holes than the customer inspector.

Having described the two sources of differences in recorded judgments of the inspectors, it remains to develop a statistical measure to detect the presence of bias in judgment. If the differences are due to chance, then it seems reasonable to assume that they follow approximately a normal distribution with a mean of zero and a standard deviation equal to the square root of the customer inspector's count.* Thus for the first category, we would have $(D_{v1} - D_{c1})$ normally distributed about zero with a standard deviation equal to $\sqrt{D_{c1}}$, where D_{v1} is the vendor's count, for a given sample, of the areas in the first category, and D_{c1} is the customer's count. Similarly for the second category, we would have $(D_{v2} - D_{c2})$ normally distributed about zero with a standard deviation equal to $\sqrt{D_{c2}}$, etc. We will have $\Sigma(D_{v1} - D_{c1}) = 0$ for any given sample, but otherwise the $(D_{vi} - D_{ci})$ will be assumed independent.

Under these conditions, the quantity

$$\frac{(D_{v1} - D_{c1})^2}{D_{c1}} + \frac{(D_{v2} - D_{c2})^2}{D_{c2}} + \ldots + \frac{(D_{vk} - D_{ck})^2}{D_{ck}} \quad (1)$$

will follow a chi-square distribution with k−1 degrees of freedom. On these assumptions, where the differences between the two sets of

*Since for samples of 100 castings, say, the true number of defects (m) in a given category, is likely to follow a Poisson distribution for which $\sigma = \sqrt{m}$, this assumption that the differences between vendor and customer inspections follow a similar law does not appear unreasonable.

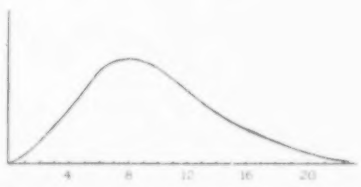


Figure 2—Curve of the χ^2 Distribution With $n = 9$

judgments are due to chance factors only, we may expect χ^2 (chi-square) to be distributed as in Fig. 2.*

It is important to understand what this curve means: if we were to repeat many times our experiment of recording two inspectors' judgments, where those differences were due to chance forces only, and to calculate χ^2 for each experiment as:

$$\chi^2 = \sum_{i=1}^{k} \frac{(D_{vi} - D_{ci})^2}{D_{ci}}$$

with k as the number of classes, we would obtain a great many values of χ^2 ranging from, say, 0 to about 22.‡ Approximately 99 percent of these values will fall between 0 and 21.67. Consequently we can assume that where we are dealing with uncontrolled data and a computed value of χ^2 is found to exceed 21.67 (for a k of 10), the reason is almost certainly not chance but an assignable cause viz., bias in judgment.

Illustration

The data in Table I will be utilized for an illustration. Specifically, the question to be answered is this: "Do the differences in defects recorded by customer and vendor register disagreements over subjective standards, or are they simply due to chance?" We proceed to compute χ^2 as is shown in the table.

Now a value of χ^2 as large or larger than 21.67 would only be found by chance less than 1/100 times.* Since our computed value of 32.95 exceeds 21.67, we are justified in inferring that there is some cause(s), other than chance, which accounts for the difference in defects observed by customer and vendor. We call this cause bias in judgment.

If desirable, we could now construct a χ^2 control chart. On the Y axis we would plot values of χ^2 with an upper control limit of 21.67, when n = 9. n indicates the number of degrees of freedom, and represents the number of cells in the χ^2 computation less 1.‡ In our problem there are ten defect classes, therefore the degrees of freedom, n, is (10—1) or 9. Now assume by way of illustration, that we obtained values of χ^2 on four different (succeeding) days as follows: 14.2, 13.9, 16.0, 32.9. We proceed to plot these data at their respective ordinates. (See Fig. 3.) Notice that the plots for the first three days are in control while that of the fourth is out of control. It is necessary to find an assignable cause for the variation in inspection judgments evidenced on the last day. Looking at Table I it is clear that the difference is largely accounted for by the following five 'cells': sand and dross, micro-shrinkage, shrinkage, cold shuts, and particularly "none". If careful attention is now given to determining the reasons for this bias in judgment with respect to these defect classes, corrective action can be taken.

It would also be possible to run a control chart on each $(D_{vi}-D_{ci})^2/D_{ci}$ if this were thought desirable. The degrees of freedom here would be one, but it must be remembered that the set of charts would not be strictly independent. A control chart for the "none" category would be especially useful for interpretive purposes. First, when it is out of control it could be taken as a measure of the extent of the overall provendor bias of the vendor inspector. Secondly, when this is out of control, charts of the other categories must be interpreted with caution. Because of the dependence, it is possible for all of the individual categories to be out of control because of high negative deviations, while the "none" class will be out of control because of a high positive deviation. This shows merely overall bias. A χ^2 computed for the nine categories, omitting "none", but still using nine degrees of freedom since the $(D_{vi} - D_{ci})$ will now be independent, will show whether there is any relative bias among these nine categories as compared with the overall bias. In Table I, for example, this second χ^2 would be 32.95 − 16.67 = 16.28, which is less than 21.67. Hence, there is only overall bias here, no relative biases among the individual categories. There is, therefore, no need to pay special attention to the differences shown for sand and dross, micro-shrinkage, shrinkage or cold shuts.

In addition to the comprehensive nature of the χ^2 test, another desirable feature of the method is its flexibility. In the example above it has been assumed that there are just two inspectors. If there are two customer inspectors working on the same material, their judgments can be summed and compared to those of the vendor.

A warning is necessary here with respect to the sample size. The sample size should be large and no 'cell' should be small. Yule and Kendall recommend a minimum sample size of 50 and a minimum 'cell' size of 5.[4] In case the number of counts in any one category should fall below five, it is advisable to combine this category with another so that the two together have a combined number of observations of five or more.

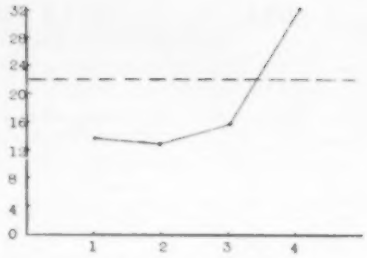


Figure 3—χ^2 Control Chart for Inspection of Castings

*More precisely,

$$f(\chi^2) = \frac{1}{2^{n} \Gamma\left(\frac{n}{2}\right)} [\chi^2]^{(n-2)/2} e^{-\chi^2/2}$$

where n, the number of degrees of freedom, is an integer and $\chi^2 > 0$.

‡Actually, the curve approaches the χ^2 axis asymptotically as $\chi^2 \to \infty$

*Tables of the integral for χ^2 can be found in most elementary statistics texts.

‡The degrees of freedom for χ^2 in this problem are k—1 because, with only one entry for each casting, once the entries for k—1 defect classes are given, the entry for the k—1 class is determined.

TABLE I—Records of Two Inspections for a Sample of Magnesium Alloy Castings

Defect Type	Vendor Inspection Record D_{vi}	Customer Inspection Record D_{ci}	$D_{vi} - D_{ci}$	$(D_{vi} - D_{ci})^2$	$\frac{(D_{vi} - D_{ci})^2}{D_{ci}}$
Sand and Dross	5	10	−5	25	2.50
Gas Porosity	6	9	−3	9	1.00
Blow Holes	7	5	+2	4	0.80
Micro-Shrinkage	5	12	−7	49	4.08
Shrinkage	10	6	+4	16	2.66
Cold Shuts	6	14	−8	64	4.57
Mottling	5	6	−1	1	0.17
Segregation	6	8	−2	4	0.50
Cracks and Rejects	6	6	0	0	0.00
None	44	24	+20	400	16.67
TOTAL	100	100			32.95

Summary

In summary our purpose is to get a quantitative measure as to the concentration and seriousness of defects which may appear in castings. The recorded judgments of the same lot of castings from both the vendor and customer are measured to determine if both the customer and vendor are interpreting the standards in the same way. This method of analysis, followed by a close liaison between the customer and foundry, will serve to focus attention for improvement on the critical areas. Once all reasonable improvement has been accomplished, sampling inspection criteria can be established which will permit a reduction in the total number of x-ray photographs necessary for adequate control.

References

(1) Boulton, B.C., "X-Ray of Aircraft Castings—Its Control and Value," *Journal of Aeronautical Sciences*, Vol. 9, no. 8, (June 1942), p. 271-283

(2) Hoel, P. G., *Introduction to Mathematical Statistics*, Second edition (New York, 1954), p. 164-170

(3) Van Horn, K. B., "Quality Control of Aluminum Alloy Castings," *Society of Automotive Engineers Journal*, Vol. 42, (Jan. 1938), p. 4-12

(4) Yule, G. U. and Kendall, M. G., *An Introduction to the Theory of Statistics*, Thirteenth edition, (London, 1945), Chapter 22

SUPERVISOR'S CIRCLE

PAUL A. ROBERT, *Editor*

Precision Products Co. of Cincinnati, Box 130, Norwood 12, Ohio

Some Observations On Acceptance Sampling

GROVER C. BALDWIN

Scovill Manufacturing Co., Waterbury, Conn.

The greatly increased use of formal acceptance sampling calls for some re-appraisal of customer-vendor relationships. It is pretty generally agreed that the adoption of formal acceptance sampling has been of benefit to vendors as well as to customers. There can be little doubt of the customer benefit—assurance of the quality level of materials in stock, prompt pressure on the vendor in cases of unsatisfactory goods, etc. As to the vendors, the results are equally satisfactory, especially to those vendors who have process quality control systems coupled with assurance sampling. It might be interjected here that a minimum satisfactory quality control program must be a three-part affair; (a) Material acceptance, (b) Process control, and (c) Outgoing assurance sampling.

This discussion will be limited to some features of customer acceptance sampling. As mentioned earlier, there has been a great increase in the use of sampling techniques. Sometimes the establishment of acceptance sampling programs has resulted in the rejection of shipments from vendors who had previously been considered as sources of top quality goods. It is well in such cases, to reappraise the quality standards as well as the ability of the inspectors. It well may be that vendor quality has deteriorated. It is equally possible that unrealistic standards are being used. In either case, the rejection of material from vendors of good reputation should result in a review of the sample by inspection supervision or other higher authority. In his paper at the 11th Annual Convention in Detroit, Mr. David G. Meckley III, of the York Division of Borg-Warner Corporation said: "In those areas where there is a definite tendency to become super-critical, we periodically have him (the inspector) inspect selected items and then discuss his determination of the quality as opposed to those of the Service Department, Sales Department and Engineering Department."

Another feature of customer acceptance sampling which has generally been applauded by vendors is that of prompt decision by the customer. It is becoming routine for customer decisions to be reported within 10 days. The question has

(Continued on page 22)

Editor's Comments

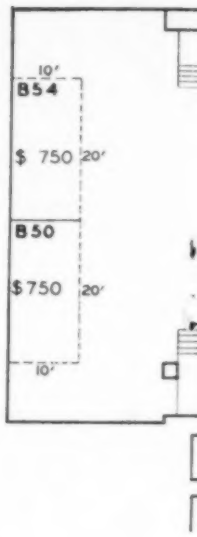
The author was asked to express himself on this subject by the Editor.

Knowing that some of the views of the author may be at variance with the practices that exist in your industry, the Editor would appreciate some comments from the readers of this column with the thought in mind that these might be published in a later issue.

We are all involved to some extent in the customer-vendor relationship. Many of the problems which arise in this area result from misunderstanding because there appears to be no "common practice" in this area. Maybe it is time to start the ball rolling.

A QUALITY SHOW FOR M

You'll never forget Boston

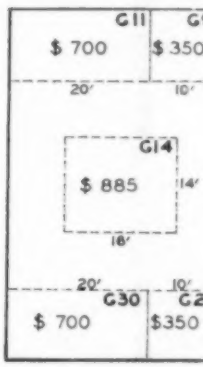


. . . where the fast growing Quality Control industry will display its progress and the reasons for its phenomenal growth at the 12th Annual Exposition of the American Society for Quality Control.

. . . where adequate exhibit space will be provided for exhibitors to tell their story to the largest audience of Quality Control engineers and executives, all eager to learn ways to control quality better.

. . . where your company should exhibit if it

- makes equipment for Quality Control
- has services or methods for Quality Control
- uses Quality Control and desires to encourage the interchange of technical "know how" by exhibiting your company's results of Quality Control applications.
- manufactures or processes any quality-controlled industrial products and wants to reach the men who specify and/or buy these products.



Join these industrial leaders by sending your space reservation now to:

American Society for Quality Control
c/o Andrews, Bartlett and Associates, Inc.
Exposition Management
1849 West 24th Street
Cleveland 13, Ohio

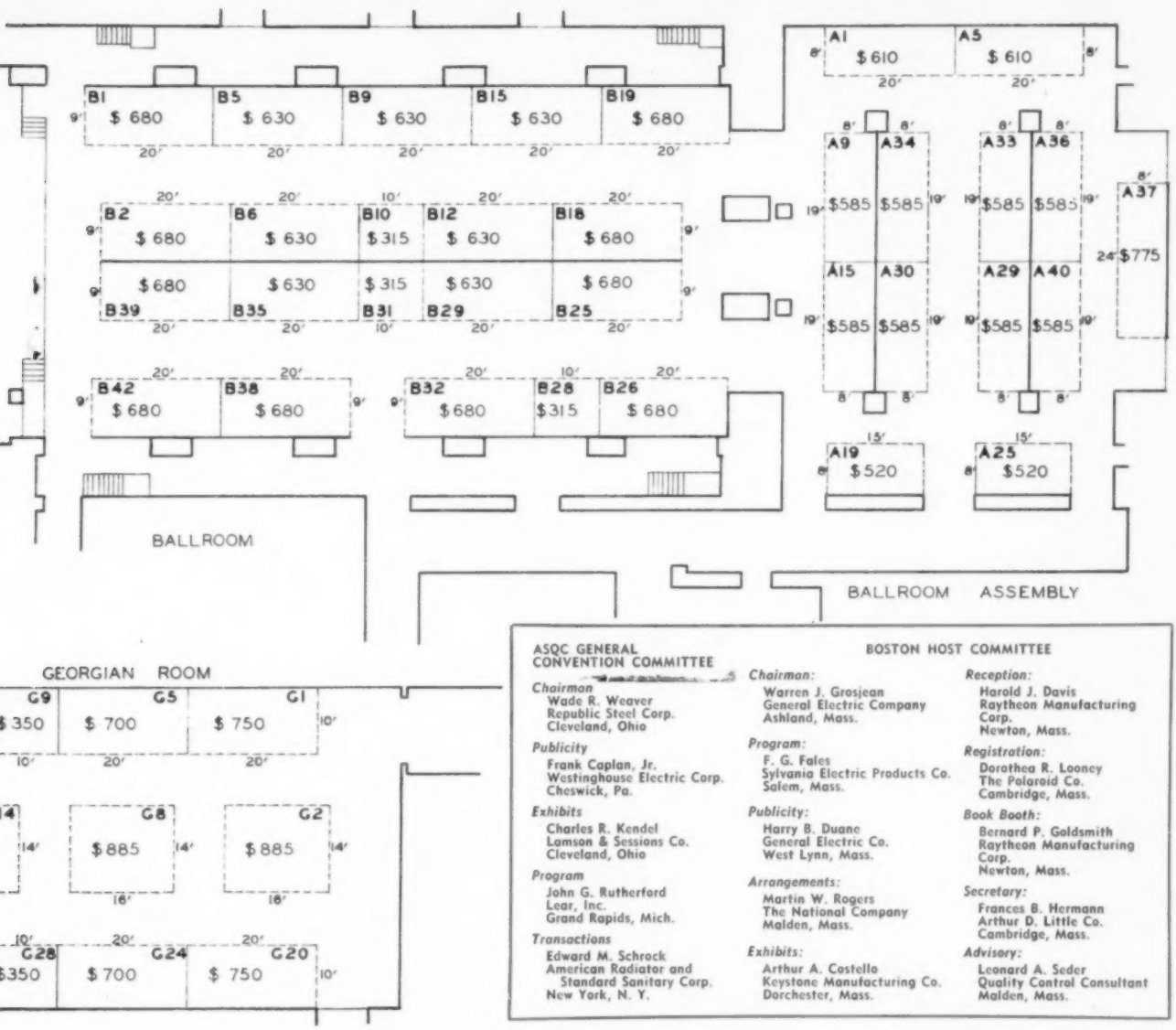
ASQC Members:

As a user of quality control your company should exhibit.

Please pass this ad on to your sales manager, exhibit manager or advertising manager right away. He will want to plan now.

Boston is a city of "Firsts" . . . first newspaper (1690) . . . first railway (1825) . . . first public school (1865) . . . first telephone call (1876) . . . first subway (1895) . . . first scheduled airline route . . . first in Research. Research laboratories in Boston area will be a prime attraction to bring Quality Control Engineers from the entire nation to Boston . . . and see your exhibit in the Hotel Statler.

MEN WHO KNOW QUALITY!



ASQC GENERAL CONVENTION COMMITTEE

Chairman
Wade R. Weaver
Republic Steel Corp.
Cleveland, Ohio

Publicity
Frank Caplan, Jr.
Westinghouse Electric Corp.
Cheswick, Pa.

Exhibits
Charles R. Kendel
Lamson & Sessions Co.
Cleveland, Ohio

Program
John G. Rutherford
Lear, Inc.
Grand Rapids, Mich.

Transactions
Edward M. Schrock
American Radiator and Standard Sanitary Corp.
New York, N. Y.

BOSTON HOST COMMITTEE

Chairman:
Warren J. Grosjean
General Electric Company
Ashland, Mass.

Program:
F. G. Fales
Sylvania Electric Products Co.
Salem, Mass.

Publicity:
Harry B. Duane
General Electric Co.
West Lynn, Mass.

Arrangements:
Martin W. Rogers
The National Company
Malden, Mass.

Exhibits:
Arthur A. Costello
Keystone Manufacturing Co.
Dorchester, Mass.

Reception:
Harold J. Davis
Raytheon Manufacturing Corp.
Newton, Mass.

Registration:
Dorothea R. Looney
The Polaroid Co.
Cambridge, Mass.

Book Booth:
Bernard P. Goldsmith
Raytheon Manufacturing Corp.
Newton, Mass.

Secretary:
Frances B. Hermann
Arthur D. Little Co.
Cambridge, Mass.

Advisory:
Leonard A. Seder
Quality Control Consultant
Malden, Mass.

Select Your Space Now!...send your application today!

12th Annual Convention and Exposition

American Society for Quality Control

Hotel Statler, Boston, Massachusetts

May 26, 27, 28, 1958

Exhibit Hours:

Monday, May 26.....8:30 AM—6:00 PM
Tuesday, May 27.....8:30 AM—6:00 PM
Wednesday, May 28.....8:30 AM—3:00 PM

(Continued from page 19)

been asked as to whether a customer who holds material for 60 days or more should expect his vendor to accept return of such merchandise. It is done but certainly with reluctance.

Whenever the problems of acceptance sampling are discussed at Section meetings or at SQC bull sessions, somebody is sure to raise the question of the return of parts which have been damaged by the customer's assembly or machining methods. This is tied up with the return of parts which are rejected by the customer's process, although the lot from which the parts came was accepted by the customer's receiving inspection. It seems obvious that there are two distinct problems. They are tied together only because the customer usually returns *all* rejects in one shipment, without designating the cause of the rejection.

All sampling inspection comprises three actions; (a) Selection of the sample, (b) Gauging and visual examination, (c) Decision and disposition.

For the moment, it can be assumed that the sample will be randomly chosen and of proper size. Thus the real problem at this point is that of standards. Are the gauges properly made? Did the vendor have the same kind of gauges? Are the visual standards those which were agreed upon when the contract was signed and when the production samples were approved? Assuming that the gauges and standards are correct, the decision should be automatic, provided sound sampling tables such as Dodge-Romig, or MIL-STD-105A are being used.

These systems require the use of well trained and experienced personnel who are adequately supervised. Without proper training, rejection decisions are apt to be made because it is easier (and safer) to reject than it is to accept. There has been many a case where production parts of even better quality than the approved samples have been rejected. This is the sort of thing which sometimes gives acceptance sampling a bad reputation. It also is costly because in one way or another, the customer ultimately pays.

In many products it is very difficult to establish dimensions and tolerances for certain important points. This results in establishing standards by the use of tags attached to those acceptable and to those not acceptable. Samples of these are retained by the customer and by the vendor for reference and ultimately become the standard.

In view of the human element involved in this area of inspection the tendency is to tighten these standards, especially in the case of items that are used in large volume and do not change dimensionally.

There have been cases where the requirements for acceptance have been made so much more stringent than the original agreement that further business has been discouraged. This sort of thing, however, can scarcely be cited against acceptance sampling. It is more certainly a customer policy problem.

As to the time lag for decision concerning acceptance or rejection of material, it is the established policy in many plants to act within three days. When parts are rejected, the production manager for that item has to sign the rejection report and arrange for return of the parts to the vendor. This requirement results in an investigation by a competent engineer to determine whether the parts are definitely not usable. Such systems are designed to prevent unrealistic rejections.

In the matter of special gauges, these is a wide range of opinion. Customer's gauge drawings have been found by many vendors to be inadequate. It is more important that the vendor's engineers get together with the customer's engineers so that each knows exactly what it is proposed to measure.

Parts that have been damaged by customer's assembly or machining methods are certainly not the responsibility of the vendor but such parts very often are returned to the vendor for credit or replacement.

Next comes the question of how long the guarantee period should be? Here again, the answer lies in the big field of company sales policy

Effective Communication in Quality Control

How companies can improve the level of quality of their production and reduce waste by better motivation and coordination will be the subject of a three-day seminar "Effective communication in QC" scheduled for Nov. 25-27 at the Harvard Club of New York City, 27 West 44th St., New York. The sponsoring organization is the Institute of Human Communication, Dover Plains, N. Y.

This will be the third seminar on this subject offered by the institute. The two previous sessions, regarded as highly successful, were attended by representatives of many of the country's outstanding corporations.

This seminar will be conducted, as were the others, by Wm. Exton, Jr., leading authority in communication; and David B. Hertz, engineer and authority in the field of operations research. Also contributing will be Professor Sebastian Littauer of Columbia University, and Dr. Paul Clifford of Montclair State Teachers College, both widely known experts in statistical quality control.

The seminar is open to qualified representatives of interested companies, but will be limited to discussion group size.

THE NEW DERMITRON

NON-DESTRUCTIVE COATING THICKNESS TESTER

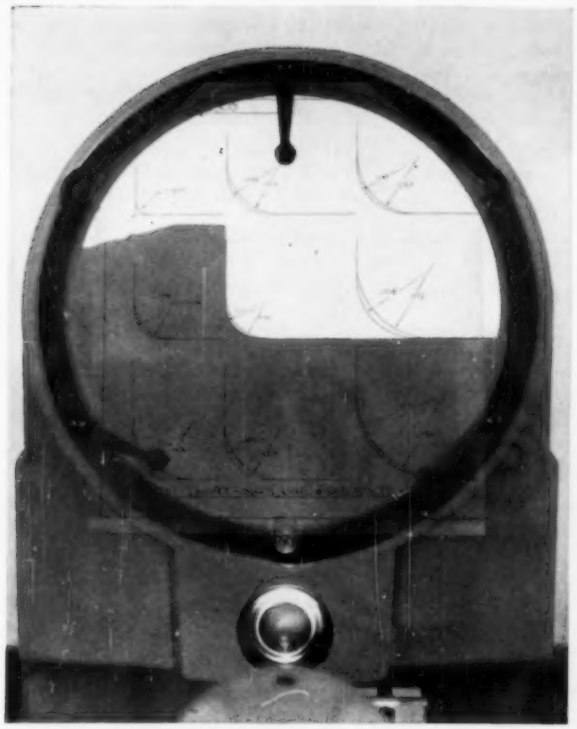
- For Metals on Metals
- Non-Conductors on Metals
- Metals on Non-Conductors

WRITE FOR FULL INFORMATION

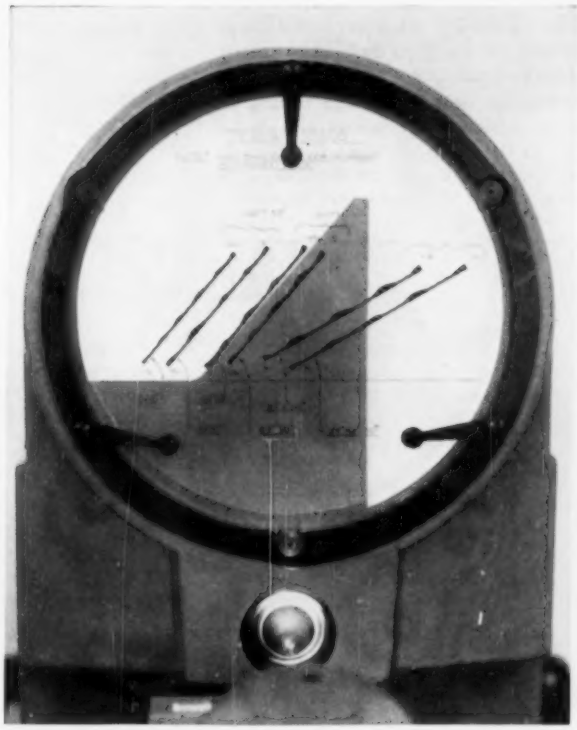
UPA

FAST
ACCURATE
PORTABLE
COMPACT
DIRECT-READING

UNIT PROCESS ASSEMBLIES, INC.
61 East Fourth Street • New York 3, N. Y.



1–A typical MS aircraft bolt has a radius tolerance of .031-.041 on the fillet where the head joins the shank. By placing up to 9 radius drawings on a single overlay chart, a number of machine operators can check fillets during production.



2–Another typical job at Standard Pressed Steel Company involves checking the angularity of a 100° flush head bolt to ½°. Angularity is checked at the same time that the radius is measured to .0015" (limits are .016-.019).

How Kodak Contour Projectors help keep gage inventories low in production checking

Standard Pressed Steel Company—manufacturer of aircraft bolts, socket screws, and other close-tolerance fasteners—once needed as many as 26 radius gages to check the fillets of *each type of bolt* it made while the bolts were in production.

Multiply this figure by the number of types of fasteners . . . add the gages required for checking other dimensions such as root radii—and you get an idea of the vast inventories involved in conventional inspection methods.

Now SPS does much of its production inspection by optical means with Model 8 Kodak Contour Projectors—and gage inventories have been slashed for these 4 important reasons:

- Light in weight, the Model 8's can be readily moved, used where needed on the production line.
- A single Contour Projector can serve several machine operators, since one screen chart can show tolerance limits for as many as nine different radii. (Fig. 1)
- A single chart can check several dimensions at once on a given part. (Fig. 2)
- By interchanging charts, the same Projector can be used to check a variety of parts—bolts, flat-head screws, or socket screws. (Fig. 3)

Model 8 and other Kodak Contour Projectors can help simplify your measurement and inspection problems, too. For full details write for our illustrated booklet, "Projection Gaging with Kodak Contour Projectors," or ask for the name of the Kodak field representative in your area. He'll be glad to advise you.

3–Here an operator uses a Model 8 Projector to check the root radius of threads to tolerances on the order of .002".

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

Apparatus and Optical Division

the KODAK CONTOUR PROJECTOR

Kodak
TRADE MARK

but certainly decision to reject should not hang on the line for more than two weeks.

Finally, how about the return of parts which are rejected at assembly in the customer's plant although the lot from which these parts came was accepted? Here again sales policy enters the picture but it is usual practice to grant credit for such parts unless their failure was the customer's fault.

In résumé, then, customer-vendor relations are improved by:

(1) Stable and well defined standards.

(2) Well trained and well supervised inspectors.

(3) Use of standard sampling plans.

(4) Prompt decision and review by the customer's receiving inspection department.

4th National Symposium on Reliability and Quality Control

The 4th National Symposium on Reliability and Quality Control is scheduled for Jan. 6-8 at the Hotel Statler, Washington, D. C. The symposium is co-sponsored by the Electronics Division of ASQC, IRE, AIEE, and RETMA.

There will be 46 speakers presenting papers of outstanding achievements in the field. Two fine panel discussions are also scheduled; "System reliability measurement" will be moderated by George M. Armour and G. M. Ryerson will be moderator of the "Reliability definitions panel". In addition, a banquet, ladies' program, transactions, and several tours are also scheduled. The tours include one each morning at 8 am to: the Naval Ordnance Laboratory; the Potomac Railroad Yard at Alexandria, Va.; and to the NBC Radio and TV station.

Three awards are to be presented at the banquet: one by the symposium committee for the best paper at the previous symposium; one by the Professional Group on Reliability and Quality Control of IRE for the best published paper presented during the year; and one award by the Electronics Division, ASQC.

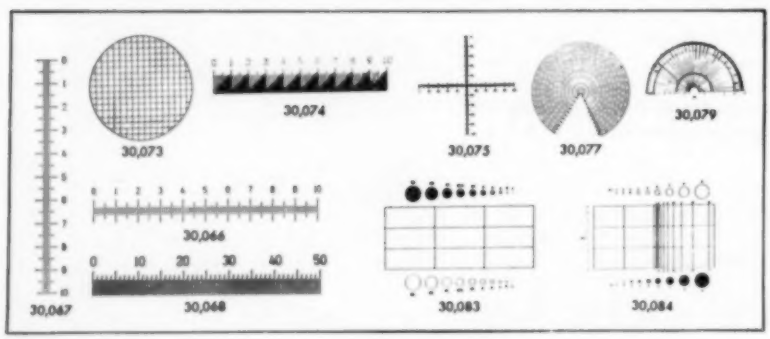
Over 4000 requests for reservations have already been received. There is space for only 1500 more. So—register early! Contact M. P. Smith, Minneapolis-Honeywell Regulator Co., St. Petersburg, Fla., *or* R. Stokes, Vitro Laboratories, Silver Spring, Md. for further information.

Here are the members of the planning committee. Standing, left to right: W. Rombach, Philco Corp.; C. M. Ryerson, RCA; J. J. Mockey, Burroughs Corp.; M. Raphelson, Burroughs Corp.; P. K. McElroy, General Radio Co.; R. M. Jacobs, RCA; H. Knapp, Federal Telephone and Radio, Inc. Seated, left to right: I. W. Schoeninger, Globe-Union, Centralab Inc.; M. M. Tall, RCA; and J. W. Greer, U. S. Navy.

What's New?

ROY A. WYLIE, *Editor*

When inquiring about "What's New?" items, please mention INDUSTRIAL QUALITY CONTROL



Edmund Scientific Co., Barrington N. J. is using a special process developed in England to produce Reticles for microscopes, telescopes, and other instruments. The Reticles are made from accurate, large size drawings then microphotographed and reduced to their final size on transparent film. The film is sealed inside two pieces of cover glass to permanently protect the image. In the illustration a number of 21mm

diameter Reticles are shown. No. 30,066—10mm horizontal scale in 100 parts; 30,067—10mm vertical scale in 100 parts; 30,068—5mm horizontal scale in 100 parts; 30,073—0.5mm squares inside circle; 30,074—Step Micrometer—10mm in 100 parts; 20,075 Crossline scales, 10mm in 100 parts; 30,077 Concentric circles, 0.5mm to 12mm; 30,079—Protractor. These Reticles are available at $5.00 each postpaid. No.'s 30,083—Patterson globe and circle; 30,084—Porton Reticle—are available at $7.50 each, postpaid.

★ ★ ★

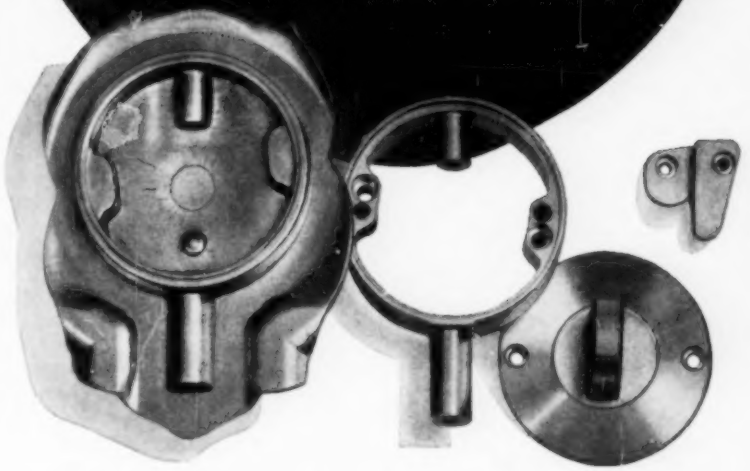
Sunnen Products Co., 7910 Manchester Avenue, St. Louis 17, Mo. has announced the Sunnen PG-800 Precision Gage. This portable comparator-type gage is entirely mechanical and has many features not previously found in one measuring instrument. It covers an unusually wide size range from ⅜ inch dia. to 1½ inch dia. and has a reading scale of 0.005 inches, calibrated in 50 millionths graduations. Accuracy is within 20 millionths of an inch; magnification is 1000:1; scale is linear over full range. The gage can be set quickly and accurately to any desired size, is instant reading and repeats consistently. A movable face plate allows full exploration of holes up to 3 5/16 inches maximum depth. The gage is easily carried and entirely self-contained. It is a practical utility gage for everyday use in the production shop and in the inspection department for accurate measurement of internal diameter, especially for checking out-of-round, taper or bellmouth. The gage is available on a "use-lease" plan—the annual fee for the PG-800 Precision Gage includes all service and maintenance costs.

★ ★ ★

In its search for a more precise method for evaluating the effectiveness of its line of TENOX feed-grade antioxidants, Eastman Chemical Products Inc., a subsidiary of Eastman Kodak Company has developed a new accelerated test to determine the oxidation stability of fats and oils and foods containing these ingredients. Most technicians have recognized the inherent errors in the commonly used Active Oxygen Method and the Schaal Oven Test for finished foods. The new test is based on the modification of the Standard ASTM Oxygen Bomb method by which gasoline stabilities

AMES

...the preferred Dial Indicators...



have forged cases, backs and wheel supports for maximum stability

Accurate measurements depend on the complete absence of interfering factors. That's why Ames Dial Indicators have forged cases, backs and wheel supports for maximum dimensional stability. The extreme care put into the design and material selection of component parts typifies the Ames approach to manufacturing a superlative product. It's just one of the reasons why the lifetime cost of Ames Dial Indicators is lower, and why so many quality control engineers specify Ames as "preferred". Write today for complete information.

Representatives in principal cities

B.C. AMES CO.

32 Ames Street, Waltham 54, Mass.

MANUFACTURERS OF MICROMETER DIAL GAUGES • MICROMETER DIAL INDICATORS

are compared. Basically the method involves placing the fat, oil, or finished food under 50 to 100 pounds per square inch of oxygen, raising the temperature to 212 F. and recording the time required for a significant pressure drop to occur. The test is carried out in a glass liner contained in a chromium-nickel alloy steel bomb which is then immersed in a boiling water bath. The combination of pure oxygen, high pressure, and elevated temperature accelerates the oxidative deterioration of the material being tested. The end point of the test is arbitrarily set as the mid-point of the first hour in which a pressure drop of at least 2 pounds per square inch occurs and which is followed by an equal or greater drop during the succeeding hour. Statistical analysis of the Active Oxygen Method, the Schaal Oven Test, and the Oxygen Bomb Method show the latter to be much more precise than either of the former methods. Other advantages of the new test are its speed, particularly in comparison to the Schaal Oven Test, and the lesser attention required by the technician during the test period. Details of the new test method are available from **Eastman Chemical Products, Inc.**, Kingsport, Tenn.

★ ★ ★

The Model 170 Portable Force Calibrator for calibrating existing weight, force and thrust measuring systems has been announced by **Gilmore Industries, Inc.**, 5713 Euclid Ave., Cleveland 3, Ohio. The instrument is a direct reading, automatic balance, digital servo indicator. The 40 pound unit is portable, and has direct digital readout, requiring no interpolation of reading and, in most ranges, no application of correction constants. System accuracy is 0.1

percent of reading or 0.1 percent of lowest range, whichever is greater. National Bureau of Standards calibration can be supplied. The indicator is calibrated with a precision strain gage load cell for tension or compression measurements. The instrument requires no batteries or standardization circuit. Provision is made for range suppression to increase the resolution and accuracy of the system. Simultaneous loading of the calibrator's load cell and the existing pick-up permits the rapid calibration of weight, force, or thrust systems. The complete unit measures 6 9/16 inches wide and 13¼ inches deep.

★ ★ ★

Moore Products Co., H and Lycoming Streets, Philadelphia 24, Pa., has announced the development of a new construction in air gaging spindles which they have trademarked "Hardcoat Plugs." These spindles are made of aluminum, with recessed nozzles and an extremely hard wear surface which is produced by a special electrolytic process. The result is a light-weight, low-cost unit which (unlike a conventional air gaging spindle) can be regarded as an expendable tool. The cost of a Hardcoat Plug is approximately 44 percent of the original cost of a conventional chrome plug. It will be, therefore, cheaper to throw away a worn Hardcoat Plug than to recondition a worn chrome plug. An unusual advantage results from the fact that the Hardcoat Plug changes color as it wears. (The wear surface is black and the base is aluminum.) The user can easily judge the condition of the spindle, and can know when to rotate the plug, in order to increase wear life. In line with the idea of low cost air gaging, the Company is also marketing a 2-D (Two-Dimension) Master Ring, which is furnished with both min. and max. dimensions on the one ring. The 2-D ring, furnished to Class X accuracy, costs less than a pair of conventional masters and provides faster calibration, since the two diameters are measured by merely rotating the master 90 degrees.

★ ★ ★

A new Digital Readout Automatic Electronic Micrometer is now being manufactured by the **J. W. Dice Co.**, Englewood, N. J., for precision measurement of fragile or compressible non-conducting materials and parts. The new motor driven Model JDR eliminates all operator discrimination other than reading the counter when contact with the work is automatically signalled. The counter has large, easy to read numerals with the last wheel reading in 20 millionths. The reading is the same regardless of who pushes the switch. Pressure on the work can be set for a negligible amount if the work is extremely fragile or compressible.

Statement of the Ownership, Management, Circulation, Etc. Required by the Act of Congress of August 24, 1912, As Amended by the Acts of March 3, 1933, and July, 1946.

Of "Industrial Quality Control," published monthly at Milwaukee, Wisconsin.

1. The names and addresses of the publisher, editor, managing editor and business manager are: Publisher, American Society for Quality Control, Inc., 6197 Plankinton Bldg., 161 West Wisconsin Avenue, Milwaukee 3, Wisconsin; Editor, Mason E. Wescott, Rutgers University, New Brunswick, New Jersey; Managing Editor, George R. Foster, 6197 Plankinton Bldg., 161 West Wisconsin Avenue, Milwaukee 3, Wisconsin; Business Manager, William P. Youngclaus, 6197 Plankinton Bldg., 161 West Wisconsin Avenue, Milwaukee 3, Wisconsin.

2. The owner is: American Society for Quality Control, Inc., 6197 Plankinton Bldg., 161 West Wisconsin Avenue, Milwaukee 3, Wisconsin.

3. The known bondholders, mortgagees, and other security holders owning or holding one percent or more of total amount of bonds, mortgages, or other securities are: none.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

GEORGE R. FOSTER,
Managing Editor.

Sworn to and subscribed before me this 23rd day of September, 1957.
(Seal)

ROSEMARY HARDING,
Notary Public.

(My commission expires April 23, 1961.)

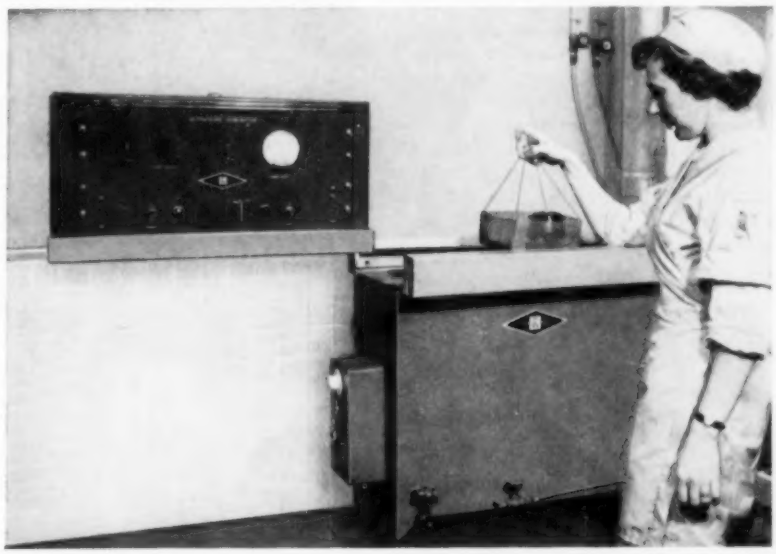
The Model JDR Digital Read-out Automatic Micrometer is a true direct reading instrument and is not a comparator. The Model JFR has a measuring range of ½ inch and a throat depth of 2 inches. Upper head is adjustable in height to accommodate work up to 1½ inches thick. Standard anvil is readily removed for use of special fixtures. Repeatability is 0.00002 inches. The Micrometer spindle is driven up by pushing the lever switch to the rear. After work is placed on the anvil the lever switch is pushed forward and held until the measurement is completed, as indicated by lighting of a small green light under the counter. An optional foot switch can be used instead of the lever switch to leave both hands entirely free for handling work. The instrument is 14 inches high, 9 inches deep, 5½ inches wide. Power required is 18 watts at 115 volts AC. The automatic control system is incorporated in a single chassis accessible by removing a base cover plate. All connections to chassis are plug-in; all indicator lamps are replaceable from the front of the instrument.

★ ★ ★

A new High Temperature measuring instrument, now being introduced by the Instrument Division of **Robertshaw-Fulton Controls Co.**, 2920 North Fourth Street, Philadelphia 33, Pa., accurately measures the temperature of hot objects without touching them. The instrument, called the Land Radiation Pyrometer, measures the radiant energy given off by hot objects. Radiant energy is correlated to the absolute temperature of the emitting surface. The instrument is useful in measuring the temperature of objects beyond the normal range of thermocouples, moving objects, and where corrosion or other conditions eliminate the use of conventional resistance temperature detectors. It is expected wide application will be found in high temperature furnaces and kilns. Temperature measurement with the Land Radiation Pyrometer is relatively independent of the distances between the detector and the object being measured. Radiation from surfaces in the open, however, will give inaccurate readings unless corrected for variations in emissivity. In using the new pyrometer, radiation from the hot object is focused on a small aperture in front of a thermopile, consisting of a bank of ten thermocouples, connected in series. A variety of lenses, depending on the use, is employed to focus the radiation on the thermopile. Only two seconds are required for 98 percent of full reading; however, a special thermopile may be obtained for 98 percent of full reading in 0.6 seconds. This feature is particularly useful when measuring the temperature of a moving object. Several models are available for ranges between 1000 and 3300 F. All instruments are sealed against dust and fumes. Two protective air purge fittings are available for use with any model to protect a beam of air along the line of focus to prevent dust and fumes from obscuring the screen or lens, or to permit the escape of air from inside the housing thereby protecting the lens from condensate. A variety of accessory equipment is available for specialized application to steel mills, furnaces, kilns, and salt bath installations.

★ ★ ★

Steel City Testing Machines, Inc., 8817 Lyndon Avenue, Detroit 38, Mich., have introduced their new model GB-124 Guided Bend Testing Machine designed to test butt-welded samples in accordance with the qualification procedure of the American Welding Society, and the



Curtiss-Wright

ULTRASONIC DEGREASERS

Make Precision Parts Ultra-Clean For Kearfott Company, Inc.

The Kearfott Company of Little Falls, N. J., makes instrument parts of such precision and delicacy that if a speck of dust should fall on a component, it could cause malfunction of the instrument. To insure scrupulous cleanliness of the parts, Kearfott uses two Curtiss-Wright DB2-5 ultrasonic degreasing units. Powerful sound waves beyond human hearing quickly remove every trace of grease and dirt without harm to vital parts.

A Kearfott engineer states: "Our Curtiss-Wright DB2-5 unit cleans the precision parts for aircraft control instruments better than any other method tried. Bearings, high accuracy electrical wound components and areas between coils where even microscopic dirt cannot be tolerated are thoroughly cleaned."

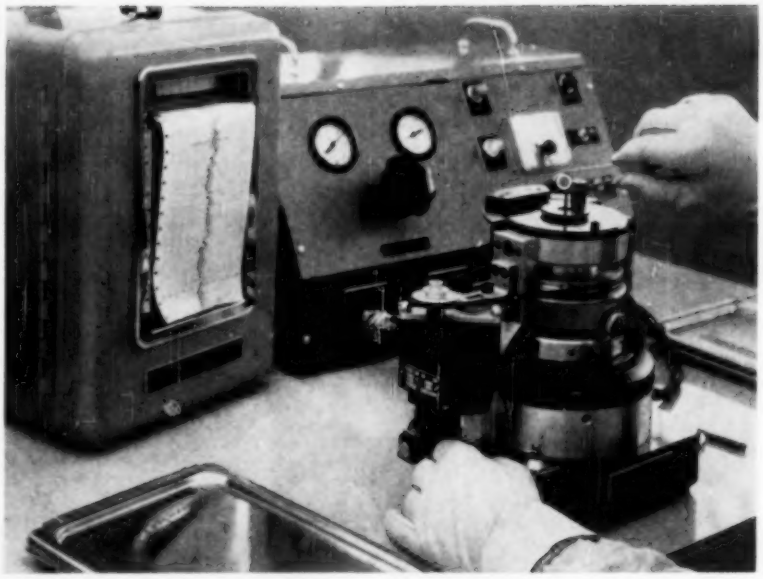
Learn how the Curtiss-Wright DB2-5 and larger units can speed up your washing and degreasing operations, lower your costs. Discuss your problem with our local representative.

INDUSTRIAL AND SCIENTIFIC PRODUCTS DIVISION
CURTISS-WRIGHT
CORPORATION • PRINCETON, N. J.

CANADIAN REPRESENTATIVE: CURTISS-WRIGHT OF CANADA LIMITED, MONTREAL

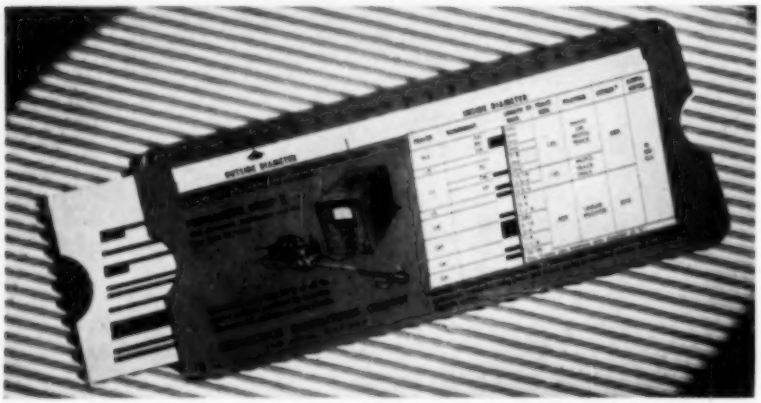
American Society of Mechanical Engineers. This is a self-contained unit designed specifically for guided bend testing with improved accuracy, faster testing and greater convenience in operation. It has its own hydraulic load-applying means; and is designed so that different fixtures for different thicknesses of metal can be quickly and easily interchanged. When testing a given thickness there is no need to remove any of the fixtures between tests, thereby keeping dies in prfect alignment. As the lower die retracts at the conclusion of a test, an ejection device operates to remove the specimen from the lower die. The tester is 70 inches high, occupies a floor space of approximately 18 by 24 inches, has a 15,000 pound capacity, and employs a ½ H.P. motor. Two hydraulic valves control pressure and directions of pistol travel. The GB-124 conforms to all requirements of the American Welding Society, and the American Society of Mechanical Engineers, regarding fixture design.

★ ★ ★



Automatic testing of instrument ball bearing torque is quickly handled with a torque tester developed by the **Fafnir Bearing Co.**, New Britain, Conn. Used mainly for testing instrument type ball bearings manufactured for control devices used in missiles, radar, and aircraft, the Torque Tester permits from twenty seven to fifty bearing inspections per hour at high sensitivity levels. A photo-electric recorder produces a tape record of the performance of each bearing. In addition to meeting the test requirements of military specification MIL-STD-206, the device has many other features of speed and accuracy. The Torque-Tester is sold complete with control cabinet, recorder, spare parts, tool kit, bearing adapters, and instruction manual. Additional descriptive literature is also available from the manufacturer.

★ ★ ★



A new Profilometer slide chart to provide a quick, accurate means for determining the right machining operation to use in getting a desired microinch finish, is available from **Micrometrical Manufacturing Co.**, 345 South Main Street, Ann Arbor, Mich. Typical applications and tolerances are also given on the same side of the chart. The other side of the chart serves as a compact set of operating instructions. By setting the arrow on the ID or OD to be measured, the chart will tell the Inspector, Quality Control Man or Engineer the proper combination of Profilometer Equipment to use. The slide device is made of tough, impregnated fiber board designed for hard use in the shop. Its size is 3⅞ × 7¼ inches and is printed in red, green and black for easy readability.

An oxygen indicator 20 times more sensitive than any such instrument previously available in the U.S. has been placed on the market by **Baker & Co., Inc.**, 207 Grant Ave., East Newark, N. J. In addition to laboratory use, the device has process applications in atomic-energy work, metals treating, and the manufacture of such products as chemicals, pharmaceuticals, electronic equipment, plastics, synthetic fibers, photographic supplies, incandescent lamps, tobacco goods, and bottled industrial gases. The Minoxo Indicator can measure traces of molecular oxygen in a wide range of gases, including hydrogen, nitrogen, ethylene, other hydrocarbons either saturated or unsaturated, helium, argon, and other inert gases. The new instrument has two ranges, 0-10 and 0-100 parts per million. When calibrated every eight hours, it has an estimated accuracy of ± 5 percent of full scale deflection. Registration of a change in oxygen concentration begins within 40 seconds and is 90 percent complete in 2¼ minutes. The gas sample is passed through a galvanic cell consisting of a silver cathode and active cadmium anode in a potassium-hydroxide solution. Oxygen is absorbed from the test gas onto the surface of the silver where it combines with hydrogen ions from the water in the electrolyte to form hydroxyl ions. These oxidize the metallic cadmium to cadmium hydroxide changing the anode's resistance and causing a current to flow through an external circuit containing an electronic potentiometer. In the 0-10 ppm range the current in the external circuit is directly proportional to the amount of oxygen

in the test gas. At higher concentrations, the response departs progressively from linearity and reference must be made to a calibration curve. The indicator cannot be used with gases containing significant quantities of impurities which would react with the silver or the potassium hydroxide. These include sulfur, chlorine, and carbon dioxide. A purified test gas to which an accurately measured quantity of electrolytically generated oxygen has been added is used to calibrate the instrument.

★ ★ ★

NEW LITERATURE

Publication and delivery of the first volume of its "Directory of

Now Available

MEMBERSHIP LAPEL BADGES

Grade of Membership	Price
Member	
Sterling Silver	$1.75
Senior Member	
10K Gold	3.75
Fellow	
10K Gold with Sapphire	4.75
Honorary Member	
10K Gold with Diamond	

Badges may be purchased only through local section secretaries except for Members-at-large who may order through the Executive Secretary.

MEMBERSHIP CERTIFICATES

Available for each of the three grades. Measures 8 × 10 inches and is suitable for framing. Individual name creatively inscribed. Cost of certificate including mailing is $3.00.

All orders for badges and certificates must be accompanied by a remittance made payable to American Society for Quality Control, Inc.

Send remittance to:
L. S. Eichelberger, Executive Secretary

American Society for Quality Control Inc.

6197 Plankinton Bldg.
161 W. Wisconsin Avenue
Milwaukee 3, Wis.

NEW!

BAUSCH & LOMB WIDE FIELD MACROSCOPES

10X to 40X

Handy 'scopes spot-check production, speed small parts work

- **Actual size as shown here ... compact, handy**
- **Shows natural right-side-up views... easier for inexperienced users... a big help in precision assembly!**

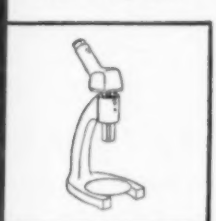
Just grab this dependable inspection aid for on-the-spot checks of work and materials in any phase of production. Available with folding tripod or sturdy microscope stand, for detailed study and for small-parts assembly. You can even build it right into production machinery!

Upright images are sharp and detailed to the very edge of the extremely wide field of view. Long working distance makes it easy to manipulate specimens ... gives operators plenty of room for precision assembly and repairs. (Also available as straight tube for applications where upright image is not required.)

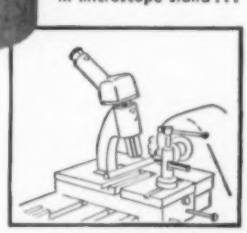
FREE DATA BULLETIN!
ON-THE-JOB DEMONSTRATION!

Find out how this inexpensive production tool can lower your manufacturing costs. WRITE, WIRE or PHONE today for free demonstrations and Data Bulletin D1052. Bausch & Lomb Optical Co., 84823 St. Paul St., Rochester 2, N. Y. (Phone: LOcust 3000).

Use it in tripod...



in microscope stand...



...or even built into machinery!

BAUSCH & LOMB
SINCE 1853

AMERICA'S ONLY COMPLETE OPTICAL SOURCE
... FROM GLASS TO FINISHED PRODUCT

Are YOU One of the 8700 members who were unable to be with us at Detroit for the Eleventh Annual Convention?

Did YOU miss out on the invaluable material contained in the 103 technical papers which were presented?

YOU can still get in on the convention! YOU can still make use of the material presented at the convention!

HOW? BY ORDERING YOUR COPY OF THE

1957 Annual Convention Transactions

The National Office still has a supply of the convention transactions available for sale to members. By ordering your copy today, you can make use of the wealth of information just as it was presented to those at the convention AND keep your quality control library right up to date with the latest techniques and applications of statistical quality control.

Here is a list of the papers contained in the 1957 Annual Convention Transactions.

- Strategy in Research
- Statistical Methods in Sorting Operations
- Statistical Studies of Rosin Sizing Evaluation Variables: IV. The Determination of Minimum-Cost Testing Procedures
- How To Use Industrial Engineering Methods Study for Quality Control
- Finding the Facts Before Setting the Specifications: II Methods
- Statistical Quality Control in Automotive Stamping Production
- Quality Control in the Manufacture of Film Coated Magnet Wire
- Quality Control in the Manufacture of Automotive Electrical Systems
- Developing Quality Standards and Ratings in Folding Paper Carton Manufacture
- Problems and Pitfalls in Acceptance Sampling of Glass Containers
- Quality Control Applied to a Job Shop
- The Design and Engineering of Test Equipment for Complex Electronic Products
- Quality Control's Obligation to Management and Customer on Reliability of Complex Weapons
- This is Inspection Automation
- A Malting Company Looks at Specifications Through Statistics
- Applications of Scheffe's Method of Paired Comparisons in Food Quality Evaluation
- The CAA Program in Quality Control
- Variability of Mechanical Properties of Flat Rolled Sheet Product
- Designing the Measurement and Analysis of Work
- Quality Control Applied to Industrial Engineering
- What is an Inspector
- Operations Research in Business and Industry
- Fractional Replication in Industrial Experimentation
- Organizing for Aircraft Quality Control
- Automotive Division First Report on Machine Tool Capability Studies
- Quality Problems of Automotive Fabrics from the Producer's Point of View
- Quality Control Training Courses: Part I, In-Plant Courses; Part II, ASQC Section Courses
- Multiple Comparisons in the Analysis of Variance
- Statistical Methods for Analyzing Performance Variations of Electronic Circuits
- Controlling the Quality of Management Decisions
- Quality Control—Its Relationship to Reliability
- An Operational Research Study on Shipping Tankage
- The Digital Computer and Its Application
- Quality Control and Production Efficiency
- Some Useful Nonparametric Significance Tests
- Initiating Quality Control and Quality Standards for New Products
- Designed Experiments in Industry
- The Team Approach in Quality Control Investigations
- Statistical Application in the Control of High Speed Filling Machines
- Semantics, Scales, and Savings Through SQC
- Quality Control From Bench to Budget
- On Some of the Necessary Ingredients of Statistical Standards of Sampling
- Managerial Statistics Applied to the Brewing Industry
- An Approach to the Vendor-Vendee Relations Program
- AQLs are Half the Story
- Sampling by Variables: I, One-Way Protection on $\bar{X}$; II, Two-Way Protection on $\bar{X}$; III, Protection on Variability; IV, Available Sampling Plans
- Quality Control in Complex Systems
- Use of Management Reports in a QC Program
- Statistical Aids to Management
- Army Quality Control and Inspection
- Contract Requirements and Quality Control
- Discovery Sampling by Attributes—Review, Revisions, and Results
- Automatic Gaging of Complex Parts by Tape Control, Etc.
- Consumer-Supplier Quality Problems and Relations
- Reporting and Analyzing Production in a Swedish Steel Plant
- Standardization and Quality Control
- Process Control in a Job-Shop
- The Proposed Military Standard for Inspection by Variables
- The Science of Quality Control as an Operation
- The Quality Manager and Quality Costs
- An Operational View of Equipment Reliability
- Quality Requirements of Automotive Fabrics
- Quality Control's Obligation to Management and Customer on Reliability
- Evaluating the Vendor
- Quality Control of Visual Characteristics
- Selection and Ranking Problems with Binomial Populations
- Quality Control in the Carton Plant
- Factors Affecting the Accuracy and Reliability of Sensory Tests
- Integration of Techniques in Process Development
- Statistics, Quality, and Control; The Essential Trio for Modern Competitive Production
- A Random Sample of Control Philosophy
- Quality Control's Obligation to Measure Terminal Quality

All This is Yours and the Price—Just $3.50 per copy.

YOU cannot afford to be without this reference material. Progress with the Society and the field of quality control.

ASQC, 161 W. Wisconsin Ave.
Milwaukee 3, Wis.

Send me.....copies of the 1957 Annual Convention Transactions at $3.50 per copy.

Amount ..... enclosed.

Name .....

Address .....

.....

YOU owe it to yourself and your company to order your copy now. Enlarge your technical and practical knowledge.

MAIL THE ATTACHED COUPON TODAY.

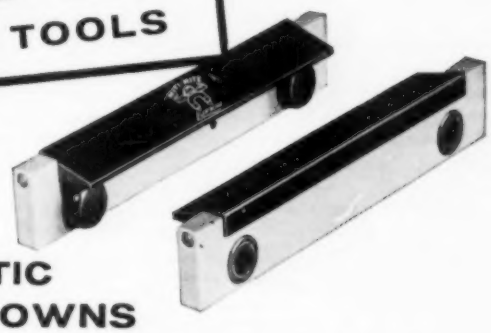
Technical Specifications" for electronic test equipment was announced by Albert F. Craig, President of Technical Information Corp., 41 Union Square, New York 3, N. Y. The Directory, which will consist of four volumes, is designed to serve the rapidly growing electronics industry by presenting information concerning the technical specifications of test instruments in an organized fashion. Three of the volumes will consist of compilations of the significant specifications and prices of virtually every standard electronic test instrument commercially available. Subscription is on a yearly basis at a cost of $270.00. In order to keep up with all the new and improved equipment which is constantly being placed on the market, the four volume Directory will be issued to subscribers in revised editions twice a year. Between revisions supplements will be issued as required. Subscribers are also entitled to a confidential advisory service providing the latest information on all instruments listed in the Directory and assistance in locating manufacturers for the construction of specialized electronic test instruments.

The new 24-page brochure describing a variety of prism and grating spectrographs, and related accessories, produced by Hilger & Watts Ltd. is being distributed in the United States by the Jarrell-Ash Company—exclusive U. S. representatives for Hilger & Watts Ltd. Included in the brochure are data on the design, application, and characteristics of each type of instrument; plus specification tables and graphs permitting quick comparison of individual performance ranges. The brochure is available from the information service of the Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

A 2-page brochure describing ten completely transistorized instruments is available from Cubic Corp., 5575 Kearny Villa Road, San Diego 11, Calif. The leaflet lists five test instruments in a self-powered series, including waveform generator, pulse generator, frequency meter, transistor curve tracer, 30 MC generator. Two power-measuring devices are listed, a calorimetric wattmeter and peakpower test set. In microwave instrumentation, the brochure describes a klystron power supply, standing wave amplifier, microwave test set.

A brochure on the Hyge Shock Tester is now available from the Rochester Division of Consolidated

NEW LUFKIN TOOLS



MAGNETIC HOLD DOWNS

A new, time-saving idea in hold downs — faster, easier and more convenient. Attaches instantly and holds to vise jaws in any position without use of shims, blocks or parallels.

Clamping edge is 3/32", will hold very thin work. Backs are tapered, forcing the work downward as the vise jaws close. A flat spring tab keeps the hold down in a horizontal position until pressure is applied.

MAGNETIC BASE HEAVY DUTY Surface Gage

A large, rugged surface gage and indicator holder. Increased base size prevents rocking . . . larger, stronger magnets permit use with lug back and other heavy indicators and attachments.

The two heavy duty magnets recessed into the solid aluminum base are completely isolated from the spindle and other parts to avoid transmission of the magnetic pull. Polarity of the magnets is controlled by a king size on-off switch that turns the magnetic pull to full on . . . full off . . . or to any intermediate point to make minor adjustments in position. Ground and lapped, contact face has a V-groove, adapting it for use on cylindrical surfaces.

New design scriber has a removable, long-wearing carbide tip which can be reversed to protect the tip from damage when not in use.

Rugged, rocker arm and large diameter fine adjustment screw permit final, precise adjustments. 9" and 12" spindles, swivel indicator attachment, indicator holding rod, and scriber with reversible carbide tip are included. 18" spindle also available.

MITI-MITE MAGNETIC BASE TOOLS CATALOG

Send for this new 12 page illustrated catalog today. Contains full information on the complete Lufkin line of magnetic base tools.

BETTER MEASURE WITH LUFKIN
TAPES • RULES • PRECISION TOOLS

THE LUFKIN RULE COMPANY, Saginaw, Michigan 478

IT PAYS TO USE YOUR INDUSTRIAL DISTRIBUTOR
. . . He offers emergency 24 hour service

Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y. It points out that this instrument provides for accurate simulation of shock experienced by equipment in actual use. The Hyge Tester is capable of producing thrusts up to 12000 pounds instantaneously and exactly with precision waveform control. Widely varying accelerating and decelerating forces can be applied for controlled time periods. It is essentially a piston in a cylinder, subjected to differential pressures on its two faces. Built of modular components, it is available in a wide variety of forms to meet any application.

A data sheet, No. 560, describing the new Stokes Line of electrical vacuum gages for continuous and accurate measurement of very low absolute pressure has just been published by the Vacuum Equipment Division of F. J. Stokes Corp., 5500 Tabor Road, Philadelphia 20, Pa. The new Stokes gages operate on the principle of a thermopile, with noble metal elements, which gives inherently greater sensitivity, fast response, and minimum contamination.

The Gow-Mac Instrument Co., 100 Kings Road, Madison, N. J., has published a new data sheet covering the Gas Blender for Quality Control of continuously flowing special atmospheres and gas mixtures used in heat treating, cutting and welding, inerting, oxygen therapy and many other fields.

A new four-page bulletin describing the BCT-300 Transistor Curve Tracer is available from the Norden-Ketay Corp., Commerce Road, Stamford, Conn. Data includes a block diagram showing the variety and flexibility of test functions, as well as specifications and photograph showing functionally located operating controls.

It's not income tax time, but . . .

Here are two suggestions that will come in handy when tax time rolls around again.

Because the Society itself is exempted as a non-profit, scientific and educational organization, *your dues payments may be deducted* as a contribution to a charitable organization.

And, *the costs of attending the Annual Convention* each year are considered deductible business expenses.

OUR EVER-GROWING FAMILY

With the addition of Battle Creek-Kalamazoo (Mich.) and Sacramento (Calif.) the number of sections in the Society is now 100. The Society is proud to extend a most cordial welcome to these new sections.

99—Battle Creek-Kalamazoo (Dist. 9)

Chairman: Guy R. Benson
The Upjohn Co.
Kalamazoo, Mich.

Vice Chairman: William Shideler
Eaton Mfg. Co., Valve Div.
Battle Creek, Mich.

Secretary: Robert C. Paris
K. V. P. Co.
Kalamazoo, Mich.

Treasurer: George R. Church
Fuller Mfg. Co.
Kalamazoo, Mich.

100—Sacramento (Dist. 16)

Chairman: William Grieson
Aerojet-General Corp.
Sacramento, Calif.

Vice Chairman: William Sherwood
U. S. Air Force
McCellan AFB, Calif.

Secretary-Treasurer: Jeanette Ashton
U. S. Air Force
McCellan AFB, Calif.

section briefs

ALLENTOWN-BETHLEHEM . . . The 1957-58 season was started with a rocket assist by Prof. Paul Clifford who spoke at the first regular meeting. A small, but enthused, group was present at the dinner meeting.

Shown at the speaker's table are: left to right: section vice chairman Dave Hilder, Western Electric Co.; Wes Sawyer, Western Electric Co.; Miss Bonnie Small, Western Electric Co.; Dr. Paul Clifford, Montclair State Teachers College; section chairman Bryn Hammarstrom, Sanduria Corp.; and Don Yateman, Dixie Cup Corp.

BALTIMORE . . . Celebrating its 10th anniversary year, the section launched the new section year on Oct. 2 with an outstanding meeting attended by about 80 persons. Leon J. Jacobson, chief engineer of IRC, Philadelphia plant and also a charter member of the section, presented a very interesting discussion of the need for new thinking and approaches to QC in our expanding technology. Dr. Acheson Duncan, Johns Hopkins University, moderated the meeting which was attended by several distinguished visitors including Leonard Seder, Besse Day, Dean Clifford James of Baltimore University plus a number of the old time members of the section. Bill MacCrehan chairmanned the meeting in his own stimulating style.

An exciting panel program is planned for Dec. 11 the moderator of which will be Dean Clifford James of the University of Baltimore. Four speakers will exchange their personal views on quality control as related to management problems and decisions.

BATTLE CREEK-KALAMAZOO . . . The American Legion Hall, Battle Creek, was the scene of the section's first fall dinner meeting on Oct. 4. This was indeed a memorable occasion for at this meeting the Battle Creek-Kalamazoo section, formerly the Wolverine subsection of the Michigan section, was presented its charter.

The charter was presented to the section by Clarence Burdick of Houdaille Industries, Inc., and a vice president of the Society. Mr. Burdick addressed the group on the growth of ASQC and the present day needs of the Society.

The regular monthly meeting will be held at 8 pm in the Post Cereals Club House, Battle Creek. The speaker for this meeting will be Robert Muir of the Lundberg Screw Co., Lansing, who will speak on "Quality control in the machine industry."

BINGHAMTON . . . Our November meeting will be a management night dinner at which time a most outstanding personality, Dorian Shainin, industrial consultant of Rath & Strong, will be principal speaker. His topic will be "Breaking through the industrial problem barrier." We are particularly elated over this event since Mr. Shainin brings to us a background of 20 years of industrial experience in both operating and consulting capacities in a variety of different industries. A writer, teacher, and speaker in the QC field, we cannot emphasize enough the honorable pleasure we will enjoy by his presence. A record attendance is expected.

BUFFALO . . . On Sept. 30, Dr. Thomas E. Caywood, Caywood-Schiller Associates, spoke to the section. The subject of his talk was "Case histories in industrial operations research." Dr. Caywood's case histories were related to the meat packing, communication, and feed industries.

Coming events—the section will soon be sponsoring a Box Course as well as an all-day clinic.

BUZZARDS BAY . . . Twenty-nine people, representing industry from Fall River and New Bedford, attended the Sept. 10 meeting. Dr. Ricardo M. Pytkowicz of Arthur D. Little Co., Cambridge, discussed "Operations research in production planning and scheduling."

CHARLESTON . . . The first meeting was held on Sept. 19 with W. H. Horton of the materials engineering department of Westinghouse Electric speaking on "Experimental design in a development organization." An interesting and instructive discussion followed the prepared paper.

Because of wide-spread interest, the section is sponsoring a basic course in QC at Morris Harvey College. Jack Massau, DuPont QC Engineer, is the instructor. An advanced course is planned to begin immediately after the completion of the basic course.

The section will not hold a meeting in December.

CHICAGO . . . A joint session with the chemical division of the Society will be held Nov. 20. The topic generally will be SQC uses in the process industry and the speaker will be Everett Hokanson, quality control supervisor, Blatz Brewing Co.

CINCINNATI . . . On Sept. 18, Nevin Bean of the Ford Motor Co. talked on "Automation and quality control in Russia." Mr. Bean was one of three engineers who visited Russian factories in 1955.

Fifty people have enrolled in the elementary classes of the education series.

On Dec. 11 Dr. Leonard W. Swanson of Arthur Andersen and Co., Chicago, will talk on "Operations research in business and industry."

The date for the 7th annual all-day conference has been set for Jan. 25. It will be a joint presentation by the Cincinnati and the Hamilton-Middletown sections. For program details and registration forms contact William Eilrich, General Electric Co., PED Quality Engineering, Evendale, Ohio.

COLUMBUS . . . The December meeting will have as its speaker E. H. Robinson, director of quality control, Johnson & Johnson.

Mr. Robinson will explain a new technique utilizing sensitive control limits of sales for making decisions in production planning.

Mr. Robinson is a founding member of the Society and for many years edited the "News Supplement" of *Industrial Quality Control.*

CORNING-ELMIRA . . . The section would like to thank Prof. Mason E. Wescott, whose appearance as speaker insured the success of the kickoff meeting for this year.

CUMBERLAND . . . A. C. Rosander, chief of the sampling and estimating methods section of the Internal Revenue Service, presented "A demonstration of quality control principles for training purposes" at the Sept. 5 meeting dinner. The descriptive and experimental approaches to teaching fundamental statistical quality control principles were explained to the group.

DALLAS-FORT WORTH . . . On Sept. 21 an all-day Texas type "outing" was held for section members, wives, and guests, at Godfrey's Ranch near Grapevine, Texas. The food, fun, and fellowship contributed tremendously to this successful event.

Dr. Carl Marshall, director of statistical laboratories at Oklahoma A&M, will talk on "New developments in statistics and what the future may hold" on Dec. 12.

Two advanced SQC courses are scheduled to be held at Arlington State College. They will run for 8 consecutive weeks and the groups will meet from 7-9 pm one night a week. Course #1 begins Oct. 29 and then on Jan. 14, Course #2 will begin. A text book has been prepared by T. E. Smith, manager of quality control, semiconductor-components division, and Dr. A. W. Wortham, head of operations research, semiconductor-components division of Texas Instruments, Inc. The course fee is $5.00 to members and $15.00 to non-members.

DANVILLE-SUNBURY . . . A dinner and plant tour of the ACF Industries plant, Berwick, were held on Sept. 26. The dinner and tour were through the courtesy of G. L. Hold, works manager, A. F. Loveland, assistant works manager, and W. F. Vorbleski, quality control manager. The tour was conducted through such areas as the railroad car fabrication building, welding car building, final inspection, forge, die repair shop, tool and die shop, and was completed with a tour through the almost finished munitions building.

DAYTON . . . The first meeting was held Sept. 19 at Frigidair Plant #1. The speaker was Dr. A. V. Feigenbaum who spoke on "Total quality control management."

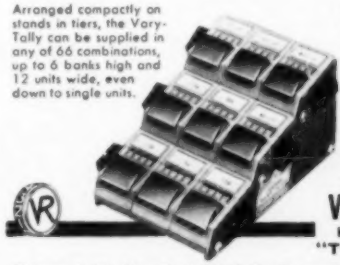
"Doll" or Dud?

Count BOTH . . . and 1,001 other items with

VARY-TALLY

Multiple-Unit Reset Counter

Using Vary-Tallies is the fast, accurate way to separate the turnover items from the "turkeys" in sales . . . the rejects from the okays in production — size by size, color by color, flavor by flavor, price by price. Because you count, you KNOW. Because you know, you COUNTROL. Tell us what YOU want to count.



Arranged compactly on stands in tiers, the Vary-Tally can be supplied in any of 66 combinations, up to 6 banks high and 12 units wide, even down to single units.

- All Parts Corrosion-Resistant; Working Parts of Hardened Steel
- Individual Tag Above Each Counter-Window — Not Strip Tabs
- Easily Readable from Any Angle . . . Bold Figures Always Centered in Window . . . No Glare

VEEDER-ROOT INC.

HARTFORD 2, CONNECTICUT

"The Name That Counts"

Chicago 6, Ill., New York 19, N. Y., Greenville, S. C., Montreal 2, Canada Offices and agents in other principal cities

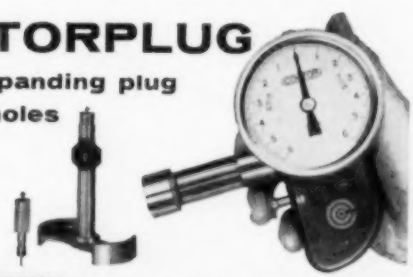
Looking for a NO-PROBLEM gage?

for tolerances down to .0001"

COMTORPLUG

unique expanding plug gage for holes

1/8" to 10" dia.



Large dial graduated to .0001"

Positive 2-point gaging shows size (actual, fixed reading) ovality, front or back taper, etc.

NO PROBLEMS:

— no electronic gear.
— no air hose.
— no base or stand.
— no training program.

. . . Used by the thousands in jet engine, automotive transmission, farm and road machinery, household appliance and other volume-precision programs.

POSITIVELY UNIFORM ACCURACY AT MACHINE & BENCH

COMTOR CO.
80 Farwell St.
WALTHAM 54
MASS.

SEND FOR FULLY ILLUSTRATED BULLETIN 50

EVANSVILLE-OWENSBORO . . . E. H. Robinson, director of quality control for Johnson & Johnson, will be the speaker at the Dec. 10 meeting to be held at Evansville College.

Mr. Robinson's subject will be "Simple techniques for adjusting production plans to sales trends." Slides will also be shown.

GREATER MUSKEGON . . . A record attendance for a "kickoff" dinner of 51 members and guests heard Frank J. Pritchard, chief of the QC section of the US Army Signal Corps Supply Agency, elaborate on RIQAP—Reduced Inspection Quality Assurance Plan. A lively question and answer period indicated high interest and excellent acceptance of the presentation.

HAMILTON . . . The first meeting on Sept. 19 featured Herbert A. French, Dominion Woolens, Ltd., Hespeler, who spoke on "Selling a QC program in the textile industry." The meeting was well attended and the large number of visitors from our local textile industry showed considerable interest in the "case histories" presented.

HAMILTON-MIDDLETOWN . . . A talk by Leon Bass, ASQC president, on "General quality control" was enjoyed by all attending the September meeting.

The December meeting will consist of a tour of the Sorg Paper Co., Middletown.

HUNTSVILLE . . . The Sept. 26 meeting was held at Decatur. Ben Morguglio, of Redstone Arsenal, spoke on the subject "Item by item sequential sampling" illustrating the techniques of sequential analysis by means of the "probability ratio" test.

KANSAS CITY . . . The section held their September meeting at the Westinghouse Aircraft Gas Turbine Plant. Following dinner in the executive dining room, A. G. Porter presented a brief talk on "The coordination between material control and quality control." A complete plant tour followed Mr. Porter's talk. Honor guest of the evening was W. W. Smith, vice president and manager of the AGT Division. Westinghouse officials who attended, in addition to regular Westinghouse members of the section, were; J. A. Murray, L. M. Meneice, A. E. Cocoros, W. E. Brown, A. G. Lass, L. F. Hillring, R. G. Miller, P. M. Sarles, and W. A. Mechesney.

LANSDALE . . . Our first meeting was held at the F. O. E. The meeting started promptly at 7:30 pm with an excellent film on the manufacture of plastics entitled "The world that nature forgot." Following the film was an hour long orientation given by our chairman, Charles G. Weidmann. He stated the activities and goals of the section for the coming year—the most important project being the doubling of the *active* membership.

Our Dec. 19 Christmas dinner meeting will be held at the ultra new Leeds and Northrup plant. One of the highlights of this tour will be an explanation of the intricate loud speaker system.

LIMA . . . The section started off its year with charter granting ceremonies. R. H. Shartle, national director, closed out a whirlwind organizing drive when he handed the section charter to Giles Howell, chairman, and Cecil Bowes, immediate past chairman, who had spearheaded the drive.

Organized as a subsection in July of 1957, the Lima group held its first membership meeting one year ago and qualified for section status last April.

LOS ANGELES . . . Frank H. Squires, director of quality control, Topp Industries, was the featured speaker at the September meeting. All who have ever heard Frank speak know that an informative and enjoyable time was had by all.

MEMPHIS . . . The University Club was host to the Sept. 27 meeting. Wade R. Weaver, quality control manager of the Rocket Fuel Division of Phillips Petroleum at McGregor, Texas, presented an enjoyable talk on "Interesting management in quality control."

A tour of the plant facilities of the Buckeye Cellulose Corp. at Memphis will be included as part of the meeting on Nov. 22, along with a discussion of the QC practices in use throughout their plants.

MID-HUDSON . . . The first fall meeting was held Sept. 3 at the Anchor Inn, Poughkeepsie, where 65 members and guests heard Dr. Paul Olmstead speak on operations Research.

The Dec. 3 meeting will be held at Beekman Arms, Rhinebeck, with G. R. Scheel as guest speaker.

MILWAUKEE . . . This year's program got off to a fine start at the Stratford Hotel with David Bair of Inland Testing Laboratory speaking on in-plant surveillance of vendor production by independent organizations. The 70 members in attendance kept the questions flying long after the meeting was officially concluded indicating their interest in this rather new concept.

Preceding the program was the first of the training sessions which covered basic statistics for QC men. Our usual social session before dinner allowed the members to slake their thirsts on the famous Milwaukee brew. This was followed by a fine buffet supper.

MINNESOTA . . . The activities for the year got off to a flying start with a well attended social meeting at the LeSueur Country Club.

The section will get its first lesson in reliability on Nov. 25 when David Bair and Paul Gottfried of Inland Testing Labs will speak on "Another look at reliability."

MONTREAL . . . The first meeting of the season was a social evening and open discussion gathering. About 45 members and guests attended and a lively discussion period was had with Ed Longhurst acting as moderator.

On Nov. 20 Charles A. Bicking, The Carborundum Co., will speak on "The team approach to installing QC."

On Dec. 11 Harold L. Freeman of the General Electric Co. will talk on "Measurements and quality costs."

NEW HAVEN . . . The first meeting of the year was an outing held in North Haven with approximately 50 members enjoying a bar-b-cued chicken dinner with all the "fixin's". Chairman Dave Albert outlined the coming events of the season in a short talk after the dinner.

NORTHEASTERN INDIANA . . . The program slated for Dec. 12 at the Chamber of Commerce in Fort Wayne will be a must to all of those who are concerned with the management of inspection and quality control.

OMAHA-LINCOLN . . . The section met Sept. 13 in Omaha. Guest Night was observed and the program was designed to tell what statistical quality control is and what it has done for us here in Nebraska. Arthur Pendray and Niles H. Barnard were in charge.

RHODE ISLAND . . . The members and friends attending James L. Dolby's talk on Sept. 19 took home with them the method whereby with random sampling the very complex problem of non-linear programming can be solved much more simply than would be the case with rigorous mathematical application.

Hardness testing made Easy!
Save Time!
Test Accurately!
Ames PORTABLE
HARDNESS TESTERS
Frequent hardness testing of metals before and during fabrication and after heat treating is essential today for best results.
Ames Portable Hardness Testers answer the need for a light weight, accurate, dependable tester that may be carried to the work for on-the-job testing. They are easy to use, require no skill, and get speedy, accurate tests wherever the work may be—no delays, no cutting off specimens—no waiting for laboratory tests.
Besides testing flats, rounds, tubing, etc. Ames Hardness Testers make tests that otherwise would be impossible, such as large gears, knives, saws, blades, struts, frames and assembled parts. Thousands are in use paying for themselves over and over again in time and materials saved.
Send for literature or ask for demonstration in your plant. No obligation.
SEMA CORPORATION
Boston 72, Massachusetts

At the Nov. 21 meeting the well known Julian H. Toulouse of Owens-Illinois will be the speaker. His subject will be "Finding the facts before setting the specification." The meeting time is 8:15 with the pre-meeting dinner at 6 pm.

ST. LOUIS . . . We were able to get an announcement of our September meeting in the local press as well as an announcement over radio station KMOX. As a result, the new season of monthly meetings opened with a very successful meeting and attendance was fine.

SAN ANTONIO . . . The first meeting of the year was held Sept. 10 at the Hilton Hotel. Our program chairman reported that four "top-notch" speakers have made commitments to visit our section during the coming year. Confirmation dates will be announced as soon as possible.

SCRANTON-WILKES-BARRE . . . Leon Bass, General Electric Co., will be guest speaker at the 6:30 dinner meeting to be held Dec. 10. It will be at the "Deitriek" Restaurant, Vine Str., Scranton. Mr. Bass' subject will be "True meaning of blueprint tolerance."

SOUTH BEND-MISHAWAKA . . . "Quality control in action" was dynamically demonstrated to the South Bend section throughout the plant tour led by and the talks given by the management of the Whirlpool-Seeger Corp. in St. Joseph, Mich. on Sept. 19. The importance of quality was everywhere in evidence in this modern, scrupulously clean home appliance factory.

"Complete acceptance" describes the section's educational committee schools for basic and intermediate statistical quality control. For the third straight year, more applications for enrollment were submitted than could be accepted.

The promotion of the "Quality control forums" is proving as successful as the famed "SQC School" introduced in 1955. This section is out to prove to the whole nation that QC is here to stay and that we are here to prove it.

TOLEDO . . . Dr. John D. C. Little, assistant professor of operations research group, Case Institute of Technology, spoke on "What is operations research" at our September dinner meeting. Through examples, Dr. Little illustrated possible applications of this technique. Dr. Julian H. Toulouse was moderator. Registrations were taken for the eight-week course in basic statistical quality control being sponsored by the section.

A delightful Christmas party for husband and wife is being arranged for Dec. 5 by Mrs. Rosemary Carroll and her committee. Dinner and entertainment are on the agenda.

TORONTO . . . The section started the season on Sept. 11 with great enthusiasm. An audience of 63 members and guests assembled in the Engineering Bldg., University of Toronto. The subject "Quality control growing pains" was dealt with confidently by the speaker, H. C. Hilditch, who is QC consultant with Deacon & Associates. A lively discussion followed.

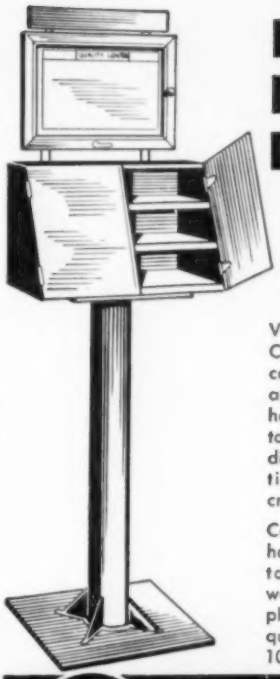
Dateline Sept. 21, Pickering Golf Club. Although handicapped by rain, there was a very fine turnout. Everyone enjoyed themselves and new friendships were made. The winner of the trophy, donated by the Monroe Calculating Machine Co. of Canada, Ltd., was Dan Hunter of IBM, Ltd. This trophy will be defended annually and we will be looking forward to next year's tournament which will again be under the able chairmanship of M. A. Smith.

On Sept. 25, the section was entertained by the management of Canadian Standard Testing Laboratories of the Canadian Standards Association in Rexdale. Members were given a plant tour. The standards that Canadian manufacturers of electrical appliances and kindred electrical products have to meet were explained. A demonstration of the methods of proving standards was given. Excellent refreshments and a lively informal discussion concluded the evening.

UNIVERSITY OF WESTERN ONTARIO . . . Fifty-four persons enjoyed dinner at the Central Hotel in Woodstock on Sept. 11, adjourning afterwards to Standard Tube to hear Mr. Gates of Owens-Illinois discuss "Finding facts before setting specifications."

Members Attention—don't forget the training course scheduled for Kitchener to be held Nov. 22-23.

WIÇHITA . . . The Sept. 10 meeting featured Robert Lair, Cessna Aircraft Co., as guest speaker. Mr. Lair inserted the management viewpoint in his speech on "What is your quality philosophy."



LOW-COST INSPECTION DEPARTMENT *for every machine in your plant*

Visi-trol free-standing Quality Control utility cabinet provides convenient live storage for tools and gages plus eye-level chart holder. Three shelves hold needed tools; doors protect them from dirt and grease. Cuts inspection time—reduces scrap—and increases efficiency.

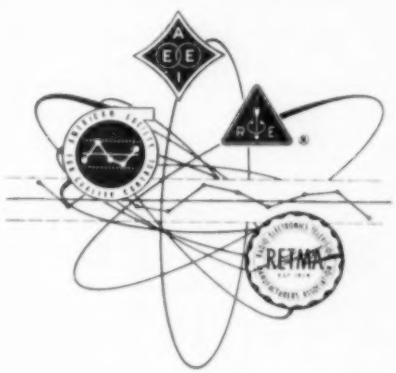
Complete assembly includes sign holder, chart holder, gage and tool cabinet, and heavy 42" welded steel stand. Price of complete outfit only $80.00; lower in quantities. Ask for Bulletin QC-1056 for complete details.

ENGINEERS • MANUFACTURERS SINCE 1946

VISI-TROL ENGINEERING COMPANY

9345 HUBBELL • DETROIT 28, MICH. • VE 6-9765

fourth national symposium on reliability and quality control in electronics



january 6, 7, 8, 1958

hotel statler • washington, d. c.

sessions • papers • panel discussions

tours • ladies program

for information contact

Selma A. Koury, Bell Telephone Co.

1843 E. Allegheny Ave., Philadelphia 34, Pa.

SECTION CALENDAR (NOV. 20—DEC. 31)

SECTION	DATE	PLACE	TIME	SUBJECT	SPEAKER
Baltimore	Dec. 11	Baltimore Memorial Stadium	8:00 pm	Panel Discussion—Management Views on Quality Control	Four Panel Speakers
Battle Creek-Kalamazoo	Dec. 6	Post Cereals Club House, Battle Creek	8:00	Quality Control in the Machine Industry	Robert Muir, Lundberg Screw Products Co.
Buffalo	Dec. 10	Iroquois Brewery	——	Plant Tour	——
Buzzards Bay	Dec. 10	Conference Room, Continental Screw Co., New Bedford	8:00	Inspection and Government Acceptance	R. J. Callahan, U. S. Navy Central Torpedo Office
Chicago	Nov. 20 Dec. 10	Lawson YMCA Elgin National Watch Co., Elgin, Ill.	6:00 Afternoon	SQC Uses in Process Foods Industry Plant Tour	Everett Hokanson, Blatz Brewing Co. ——
Cincinnati	Dec. 11	Engineering Society Bldg.	8:00	Operations Research in Business and Industry	Dr. Leonard W. Swanson, Arthur Andersen & Co.
Columbus	Dec. 11	Ranco, Inc.	8:00	Simple Techniques for Adjusting Production Plans to Sales Trends	E. H. Robinson, Johnson & Johnson
Corning-Elmira	Dec. 10	Westinghouse-Horseheads	8:00	Quality Control in Action at Westinghouse	——
Cumberland	Dec. 5	Ali Ghan Country Club	6:30	Design of Experiments—How to Get Results	J. H. Davidson, General Electric Co.
Dallas-Fort Worth	Nov. 26	Arlington State College	7:00	Course in Advanced SQC (Meets each Tuesday night with final session on Dec. 17)	——
	Dec. 12	Arlington State College	8:00	New Developments in Statistics	Dr. Carl Marshall, Oklahoma A&M
Evansville-Owensboro	Dec. 10	Evansville College	7:00	Simple Techniques for Adjusting Production Plans to Sales Trends	E. H. Robinson, Johnson & Johnson
Greater Muskegon	Dec. 12	Bill Stern's Steak House	6:30	——	Leo Harrington, King Seeley Corp.
Hamilton	Nov. 21 Dec. 12	Fischer's Hotel Westinghouse Auditorium	6:30 8:00	The Human Factors in Business & Management Improved Quality Control Through Quality Audit	Prof. B. Moore, Massachusetts Institute of Technology S/L G. B. Waterman, RCAF
Hamilton-Middletown	Dec. 11	Sorg Paper Co., Middletown	8:00	Plant Tour	——
Huntsville	Nov. 21	——	7:30	General Applications	David Chambers, University of Tennessee
Lansdale	Dec. 19	Leeds and Northrup, North Wales	6:30	Dinner and Plant Tour	Santa Claus
Los Angeles	Dec. 10	Rodger Young Auditorium	6:00	The SPAN Plan	David Cowan, Hughes Aircraft Co.
Memphis	Nov. 22	The Buckeye Cellulose Corp.	8:00	Quality Control in Action at the Buckeye Cellulose Corp.	Dr. Arthur F. Johnson, The Buckeye Cellulose Corp.
Mid-Hudson	Dec. 3	Rhinebeck	7:00	QC in Hearing Aid Manufacture	G. R. Scheel, Sonotone Corp.
Milwaukee	Dec. 10	Marquette University Union	6:00	Ladies Night	Prof. Gayle McElrath, University of Minnesota
Minnesota	Nov. 25	——	——	Another Look at Reliability	David Bair and Paul Gottfried, Inland Testing Labs
Montreal	Nov. 20 Dec. 11	LaSalle Hotel CIL Bldg.	6:30 8:30	The Team Approach to Installing Quality Control Measurements and Quality Costs	Charles A. Bicking, The Carborundum Co. Harold L. Freeman, General Electric Co.
Northeastern Indiana	Dec. 12	Chamber of Commerce, Fort Wayne	8:00	Management of Inspection and Quality Control	O. H. Bishop, Reynolds Metal Co.
Rhode Island	Nov. 21	Providence Engineering Society Bldg.	8:15	Finding the Facts Before Setting the Specification	Dr. Julian H. Toulouse, Owens-Illinois Glass Co.
Rochester	Dec. 3 Dec. 9 Dec. 17	Chamber of Commerce Chamber of Commerce Chamber of Commerce	6:15 6:15 6:15	Programming & Some Related Statistical Problems —— Let's Quit Using an Elephant Gun to Shoot Flies	Dr. Clifford Hildreth Dr. Howard L. Stier, National Canners Association Dr. Fred A. Beeler, Western Michigan College
St. Louis	Dec. 13	Golden Fried Chicken	6:30	Business Application of Statistical Methods	R. B. Shartle, Standard Register Co.
San Antonio	——	——	——	——	Dr. Carl Marshall, Oklahoma A&M
Scranton-Wilkes-Barre	Dec. 10	Deitrick Vine Str. Scranton	6:30	True Meaning of Blueprint Tolerance	Leon Bass, General Electric Co.
South Bend-Mishawaka	Nov. 21 Dec. 5	Bendix Legion Post, South Bend YMCA, South Bend	7:30 7:30	Organizing for Operations Research QC Problems Forum	H. Hubbard, United Airlines, Inc. J. F. Gyoles (moderator), Bendix Products Div.
South Texas	Dec. 11	Ben Milan Hotel, Houston	7:15	Don't Stop with the Control Chart	Dr. Carl Marshall, Oklahoma A&M
Toledo	Dec. 5	Tally-Ho	7:00	Christmas Party (arrangements by Mrs. Rosemary Carroll)	——
Toronto	Nov. 21 Dec. 11	Fisher's Hotel, Hamilton University of Toronto	8:00 8:00	The Human Factor in Business and Management An Example of SQC and MTM Operation	Prof. B. Moore, Massachusetts Institute of Technology F. G. Thompson, Shirriffs, Ltd.
Univ. of W. Ontario	Nov. 22-23 Dec. 4	Kitchener Kitchener	—— 6:30	Basic Training Course The Importance of Measurement in Industry	A. Deacon & Associates Ralph Presgraves, J. D. Woods & Gordon
Worcester	Nov. 21 Dec. 12	Hickory House Worcester Polytechnic Institute	6:30 7:00	Panel Discussion The Control of Quality and Cost in Clerical Work	Moderator and Four Panelists A. C. Rosander, Internal Revenue Service

Frank Backstrom, Wichita city manager, presented "Quality Control in the city government" at the Oct. 1 meeting. This was very timely in that Mayor E. E. Baird had signed a proclamation declaring a "Wichita Quality Control Week" earlier that day.

The section is conducting a six week educational program. It consists of one night-a week lectures with three plant tours scheduled along with three of the lecture sessions.

WINDSOR . . . The section began its fall program on Sept. 11 with a plant tour of H. J. Heinz Co., Ltd., Leamington. This tour was enjoyed by a group of 68 which included members and their guests. A talk on company background and a discussion on quality problems along with light refreshments completed the evening.

The Sept. 25 dinner meeting at the Prince Edward Hotel featured B. D. (Ben) Witemeyer, manager of the fixed gage and inspection room, Instrument Division of the Sheffield Corp. His subject was "The five echelons of accuracy."

The December meeting will take the form of a Christmas party for the members and their families. Individual detailed notices will be forthcoming at a later date.

WORCESTER . . . A very successful suburban area meeting was held at the Westboro Country Club. This was a social event to stimulate membership growth. An interesting talk on "Aids to gaining acceptance of your QC suggestions," a human relations discussion, brought many questions from the audience.

The panel discussion planned for the meeting Nov. 21 includes a discourse on "Setting up a quality organization," "Pitfalls of quality operations," and "How best to avoid them" as well as other topics. There will also be a question period for the audience after the panel discussion.

. . . SIGNIFICANT DIFFERENCES

. . . Cincinnati—William J. Hill has accepted a position as quality engineering manager with the Ford Instrument Co., New York City. He was applications chairman of the section.

. . . Corning-Elmira—Jack E. Mounteer has been appointed western region sales engineer for Electric Component Parts by Corning Glass Works. Mr. Mounteer was formerly quality control manager of the Electrical Products Division.

. . . Hamilton-Middletown—Francis Cheng, Pillsbury Mills, Inc., Hamilton, is being transferred to Pillsbury Research and Development Department, Minneapolis, Minn.

. . . Kansas City—The section was pleased to learn of the promotion of Orris Stewart, Bendix Aviation Corp., to the position of general foreman. Mr. Stewart was in charge of the regular pre-dinner discussion on basic inspection techniques and equipment last year, and will be handling this very popular program activity again this year.

. . . Los Angeles—Eleanor Schlifer, section reporter, has left the area to take a position with the Operations Research Co. of Monterey.

. . . Milwaukee—Darrell Schroeder of Globe-Union, Inc. has assumed the duties of section treasurer due to the resignation of Peter Gates.

Mitch Kolsam, formerly QC statistican with Republic Steel, Cleveland, is now a statistician with General Merchandising Corp. Milwaukee.

. . . Northeastern Indiana—Gid Statts of Fort Wayne and the International Harvester Co. is again teaching the fundamentals of quality control on the staff of Purdue University Extension, Fort Wayne.

. . . St. Louis—The section has been elected to membership in the Joint Council of Associated Engineering Societies of St. Louis.

. . . Scranton-Wilkes-Barre—E. Barrows was promoted as head of a new division opened recently in Scranton. This new division is affiliated with The Inspector of Naval Material, Reading, and will cover seven counties in northeastern Pennsylvania.

. . . South Texas—C. H. Bone, a past chairman and charter member of the section, was recently promoted from assistant works metallurgist to a newly created position of processing analyst at the Houston plant of the Sheffield Division of the Armco Steel Corp.

. . . Toledo—Congratulations to Ray E. Crouse on his appointment to a new job! He is now employed as process supervisor at the Dura Div., Detroit Harvester Co., Toledo. Ray, a graduate electrical engineer, is past chairman of the section and is presently president of the Toledo Technical Council.

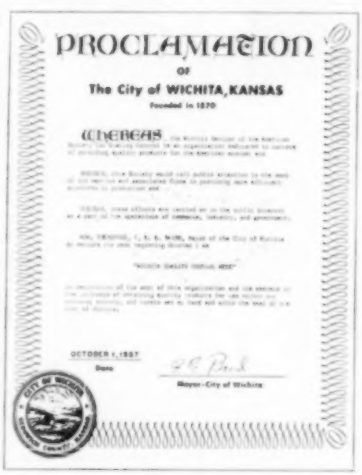
Margaret Tobin has taken a position with The General Tire and Rubber Co. as junior QC engineer. Margaret, a graduate in mathematics, was formerly employed by the Ransom and Randolph Co. as a SQC analyst.

. . . Muncie—Seldom has a Muncie Rotary speech received more thoughtful attention than was accorded when our own D. G. "Brownie" Browne discussed the prosaic subject of quality control at the August meeting of the Muncie Rotary. He made it come alive, applied it to their everyday jobs, in a most lucid and dramatic way.

. . . Wichita—Glen Hetrick, general supervisor of quality control of Beech Aireraft Corp. has recently been given a special assignment as staff assistant to the vice president of manufacturing. Mr. Hetrick has been assigned to this new position for a temporary period and will then return to his former position.

WICHITA QUALITY CONTROL WEEK

On the morning of October 1, Mayor E. E. Baird, City of Wichita, signed and affixed the seal of the City of Wichita to a proclamation declaring the week beginning October 1 as *Wichita Quality Control Week*.


PROCLAMATION

OF

The City of WICHITA, KANSAS

Founded in 1870

WHEREAS

OCTOBER 1, 1957

Mayor-City of Wichita

This proclamation was made at the request of the Wichita section to call public attention to the science of quality control and to make business concerns and the citizens of Wichita aware of the importance of quality control in the American economy.

The words "quality control" are rapidly becoming a by-word of the American public. It is used extensively in advertising all types of products in newspapers and magazines, on radio and television, as well as on highway road signs. This use of the word "quality", and the recognition and acceptance of it by the American public, places a moral obligation on every person in the quality control profession. This obligation is:

First—Promote the further use of quality and quality control in our everyday living as well as our business.

Second—Make this media of advertising have true meaning by assuring that articles purchased meet the standards or requirements advertised.

Third—Promote an understanding of quality control with the public in general.

The designation of the "Wichita Quality Control Week" is but one of the means being utilized by the Wichita section in meeting this obligation and promoting and stimulating interest in quality control. The program for the entire year will follow a theme of "Quality Control in Wichita." Such topics as "Quality Control in the City Government," "Quality Control in the School System," "Quality Control in Merchandising," "Quality Control in the Small Manufacturing Plant," as well as other topics will be used to present a cross section of quality control in the city of Wichita.

The Wichita Section sincerely hopes to have "Wichita Quality Control Week" each year and perhaps be part of a national Quality Control Week at some future date.

Want a Section Library?

In the summer of 1953 the executive committee of the Albany section extended its educational program by establishing a rental library. Fifty dollars was appropriated and 12 books were purchased. An additional appropriation of $40.00 was made in the fall of 1954. Besides these appropriations, there has been income from two sources—book rentals and book orders. During the four year period of operation, the library has made 111 book-month rentals at a charge of 25 cents per month. With respect to book orders, 112 books have been ordered as personal purchases by members.

The income received from book rentals has more than taken care of the running expenses of the library. These include supplies such as post cards and stamps, and those sometime necessary long distance calls. The income realized from the sale of books (the section library purchasing the books at a net price and selling them at list price to members) has been used to increase the collection. The result—the original 12 book collection has now reached 52; a few of these have been donated.

Books are displayed at each meeting on racks set on a table. (The photo is a typical meeting setup. Shown, left to right, are: Wyatt H. Lewis, General Electric Co., New York; Nura Turner, book chairman and assistant professor of the Department of Mathematics, New York State College for Teachers, Albany; and Charles D. Ferris, Mohasco Industries, Amsterdam, N. Y.) The transportation of the racks and books to and from meetings has been somewhat of a problem. It has not been possible, nor feasible, to keep the books at the place of meeting. They have been kept at the office of the book chairman and picked up and returned each meeting time by one of the section members.

The first 12 books ordered were selected at the discretion of the book chairman. Those ordered since have been ones in which members have expressed an interest, and recent publications.

The procedure of ordering, whether for the library or for a member's personal order, has been simple. A request on a post card has been sent to the publishing house concerned (the book chairman at the outset had to establish herself as an agent with publishing houses in order to be eligible for commissions); the publishing house returns the book and then invoices the section; if the book has been ordered by a member, he is notified by post card and the member in question returns his remittance; the book chairman then concluded the deal by sending the publishing house a check.

The library has been a spot of interest at meetings. Members collect at the table during the cocktail hour between the afternoon problem session and dinner, and again between dinner and the evening speech.

The library has been of service to the section as can be noted from the rentals and orders. It has also been of service outside the section when requests for rentals or purchases have been handled for ASQC members other than section members.

Any sections wanting more information about "section libraries" may write to Nura Turner, Asst. Professor of Mathematics, New York State College for Teachers, Albany, N. Y.

clinics, conferences, and courses

NOVEMBER

. . . **25-27**—Effective Communication in QC, Harvard Club of New York City, 27 West 44th St., New York, sponsored by Institute of Human Communication, Dover, Plains, N. Y.

DECEMBER

. . . **1-6**—ASME Annual Meeting, Hotel Statler, New York, N. Y.

. . . . **2-5**—Nuclear Program, Hotel Statler, New York City, American Society of Mechanical Engineers, contact F. D. Acker, Combustion Engineering, Inc., 200 Madison Avenue, New York 16, N. Y.

. . . . **9-13**—Eastern Joint Computer Conference and Exhibition, Sheraton Park Hotel, Washington, D. C., co-sponsored by Institute of Radio Engineers, Association for Computing Machinery, American Institute of Electrical Engineers, contact Richard T. Burroughs, Registration Chairman, 1957 E.J.C.C., IBM Corp., 1220 Nineteenth Street, N. W., Washington, D. C.

. . . **26-31**—American Association for the Advancement of Science, Indianapolis, Ind.

JANUARY

. . . ***6-8—4th National Symposium on Reliability and QC in Electronics, Hotel Statler, Washington, D. C., sponsored by RETMA, AIEE, IRE, ASQC, contact Richard M. Jacobs, Publicity Chairman, RCA, Box 33, Camden, N. J.***

. . . ***12-23—Statistical Methods for Process Development, Harvard Business School, sponsored by Chemical Division, ASQC, fee $375, contact Richard S. Bingham, Jr. (SMPD), The Carborundum Co., Research & Development Division, P.O. Box 337, Niagara Falls, N. Y.***

. . . **13-17**—Supervisory Development Course 3, given in three one-week units (Jan. 20-24, Feb. 24-28), Penn Sherwood Hotel, Philadelphia, sponsored by AMA, contact Course Registrar, American Management Association, Inc., 1515 Broadway, New York 36, N. Y.

. . . . **30-31**—New Concepts in the Education and Development of Technical Manpower, University of Michigan, sponsored by American Society for Engineering Education, for further information contact the University of Michigan College of Engineering, 255 West Engineering Building, Ann Arbor, Mich.

. . . **30-31**—New Concepts in the Education and Development of Technical Manpower, University of Michigan, sponsored by American Society for Engineering Education, for further information contact the University of Michigan College of Engineering, 255 West Engineering Building, Ann Arbor, Mich.

FEBRUARY

. . . **3-4**—National Conference on Progress and Trends in Chemical and Petroleum Instrumentation, Wilmington, Dela., sponsored by ISA. Contact, H. S. Kindler, Director of Technical Programs, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

BOOK REVIEWS

W. D. Baten, Editor

26 University Drive, East Lansing, Mich.

STATISTICAL METHODS IN QUALITY CONTROL, by Dudley J. Cowden, xxiv plus 727 pages, published by Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1957, price $8.25. Reviewed by A. Clifford Cohen, Jr., University of Georgia.

This book seems to have been written primarily as a manual or handbook for quality control supervisory personnel. It should also interest production and inspection supervisors and engineers. In the author's preface, he points out that consistent with the title, statistical methods in quality control are emphasized. Other aspects of quality control are treated only briefly. No problems or exercises for solution by the reader are included, and this lack will accordingly impair the book's usefulness as a text.

The book is comprehensive in scope and a large number of topics are treated quite fully and effectively. The first twelve chapters deal mainly with statistical methods and include illustrations from the field of quality control. Chapters thirteen through twenty-nine are concerned chiefly with process control. Chapters thirty through forty deal with product control. Mathematical derivations of the more important formulas are given in considerable detail. Some of the more tedious proofs and derivations are relegated to appendixes which appear at the ends of the chapters.

Excellent collections of tables and charts are reproduced as appendixes at the end of the book. These include tables of squares, square roots and reciprocals for the numbers 1-1000; five place tables of common logarithms, binomial coefficients up to $\binom{50}{25}$, factorials and their logarithms of the numbers 0-200, powers of selected decimal fractions, probability of d or fewer defectives for selected binomial distributions, alignment charts for the standard deviation and skewness of the binomial distribution, charts for obtaining confidence limits on p in binomial sampling, five place tables of the normal curve area and ordinates, values of chi square for specified probabilities, and various other tables of interest to the industrial statistician.

A carefully prepared glossary of symbols is included. The book is well written in concise language that should be readily comprehended by the average reader.

ELEMENTS of SUPERVISION, 2nd. Edition by Wm. R. Spriegel, Edw. Schulz, and Wm. B. Spriegel, 349 pages, John Wiley & Sons, Inc., New York, 1957. Reviewed by James M. Apple.

The original edition of this book was published to help in the training of supervisors for wartime industry. It was based on a background of extensive training of supervisors by the authors.

The new edition is even more complete than the first in its coverage of the duties and responsibilities of the industrial supervisor. The book opens with the first few chapters devoted to the supervisor and his place in the organization, his role in interpreting company policies to his men, and his task of representing his men to management and vice versa.

The major portion of the book is then devoted to a very complete coverage of the various responsibilities and activities of the supervisor. Each is discussed in detail to aid the supervisor in properly understanding his job, his men, and the important interrelationships between the various roles he must play as a successful supervisor.

The book also contains an appendix on the fundamentals of statistical quality control, and a brief general bibliography.

The book should be very useful as a "text" for a supervisory training program, or as a general reading for supervisors.

POSITIONS WANTED

Address all replies to box number references to: American Society for Quality Control, Room 6197 Plankinton Bldg., 161 W. Wisconsin Ave., Milwaukee, Wis.

QUALITY CONTROL SUPERVISOR
Masters degree in Statistics. Five years as analyst, engineer and supervisor in the research, pre-production and production phases of quality control. Desire $11,000 in location of New Jersey to Indiana and all states directly South. Resume available at Box 14E1 at the above address.

Situation wanted as Quality Control Manager. Fifteen years responsible positions in Quality Control and Manufacturing of precision machined parts and assemblies. Mechanical Engineering degree. Please reply to Box 14E2 at the above address.

CLEVITE

QUALITY CONTROL MANAGER

Starting Salary $8000 to $11,000

The overall uses of transistors are multiplying. Our products are well-accepted. Our customers are top-flight, blue chip companies to whom quality is paramount. A great percentage of our success is attributable to our strong quality control program.

To qualify, a degree in EE or Physics is required. Should have experience in electronic component quality control, or as a semi-conductor engineer.

Send resume in confidence to Personnel Director

CLEVITE
TRANSISTOR PRODUCTS
257 Crescent St., Waltham 54, Mass.

Product Education Service

These advertisers provide educational information on their products, expanding the services of your journal, *Industrial Quality Control.*

Their support is twofold. First they place the latest information on product development at your finger tips. In addition their purchase of advertising space supports your Society and this publication. Continue to advance your Society by using their products and services and encourage others to do so. They all merit your consideration.

When writing or talking to advertisers to inquire about their products, always remember to say you saw their ad in *Industrial Quality Control.*

Advertisers in this issue

B. C. Ames Co. 25
Bausch & Lomb Optical Co. 29
Bell Telephone Laboratories, Inc. 1
Comtor Co. 33
Curtiss-Wright Corp. 27
Dearborn Gage Co. .....IFC
Eastman Kodak Co. 23
Federal Products Corp. .....OBC
Lufkin Rule Co. 31
Norton Co. .....IBC
Semo Corp. 34
Unit Process Assemblies 22
Veeder-Root, Inc. 33
Visi-trol Engineering Co. 35

Advertisers in previous issues of Volume XIV

Allied Radio Corp
R. G. Bock Engineers
Electric Storage Battery Co.
Elliott Service Co.
Friden Calculating Machine Co., Inc.
Gaertner Scientific Corp.
Hughes Aircraft Co.
Lightning Calculator Co.
Sheffield Corp.
Steel City Testing Machines, Inc.
John Wiley & Sons, Inc.

QUALITY CONTROL

Corning Glass Works, leading manufacturer of industrial and technical glassware, has openings in statistical quality control.

Engineering, mathematics or statistics background desirable.

With Corning, your work will include:

Statistical Machine Analysis
Machine Capability Studies
Sampling Techniques
Process Analysis
Process Control

Send resume to:

Mr. Frank P. Hudson
CORNING GLASS WORKS
Corning, N.Y.

Makers of PYREX Products

QUALITY CONTROL

Expanding and diversified organization has permanent and interesting openings for top-level QC Engineers and Managers at several locations. Please submit complete details of education, experience, and earnings in confidence to:

WILLIAM PLANT,
CENTRAL PERSONNEL

THE GENERAL
TIRE & RUBBER COMPANY
AKRON 9, OHIO

Change of Mailing Address

Prompt notification of a change of address enables us to correct your records at the Headquarters Office, correct your mailing address for *Industrial Quality Control*, and notify your section to correct their mailing list. Therefore, if you move, fill out this form and mail to ASQC, 161 W. Wisconsin Ave., Milwaukee 3, Wis.

—Office Use Only—
Do not write in this space
Ser. No. .....
State Code .....
City Code .....
Section Code .....

Name .....

New Address .....

.....

(city) (zone) (State)

Also to insure complete information in our records, please fill in the following if it has changed.

ASQC Section ..... Job Title .....

Company .....

Co. Address .....

IMPORTANT: Please do **not** use ball point or other dye-type inks. This form will be Thermofaxed and thus requires pencil, metallic-base inks or typewriters. 11-57

POSITIONS AVAILABLE

Address all replies to box number references to: American Society for Quality Control, Room 6197 Plankinton Bldg., 161 W. Wisconsin Ave., Milwaukee, Wis.

Junior Quality Control Engineer

Approximately one year experience. Should have some knowledge of inspection methods, trouble shooting, statistical quality control and quality control procedures. Prefer graduate engineer or equivalent. Please submit resume including salary requirements to:

Ronson Corporation of Pennsylvania
Delaware Water Gap, Pennsylvania

CONSULTING SERVICES

Responsibility of the American Society for Quality Control, Inc., for Consulting Services advertising is limited to certification that advertisers hold the grade of membership in the Society stated in their advertisements. Qualification requirements for the several grades of membership are set forth in the Constitution of the Society.

Consulting Services in Quality Control
RALPH E. WAREHAM
Fellow, ASQC
122 Orchard Ridge, Chappaqua, New York — Telephone Chappaqua 1-0715

Quality Control Consultant
HARMON S. BAYER
Fellow, ASQC
1154 Book Building, Detroit 26, Michigan — Telephone WOodward 5-3796

QC Planning — Defect Prevention
LEONARD A. SEDER
FELLOW, ASQC
267 HAWTHORNE ST.
MALDEN, MASS.
MAlden 4-5446
Organizing for Quality — Training

BERNARD HECHT
Quality Control & Reliability Specialist
Senior Founding Member, ASQC
Planning and Staffing
Q. C. Organizations
Training in Statistical Methods
Quality Assurance Programs
5410 Wilshire Blvd. Los Angeles 36, Calif.
WEbster 8-0121

Management Controls
FOUNDED IN 1945
References and Literature on Request
Senior Partner: W. E. JONES *Fellow, ASQC*
699 Rose Ave.
DES PLAINES, ILL.
Vanderbilt 4-6533

The "RIGHT COMBINATION" for every reinforced grinding wheel

...because Norton builds in the "Touch of Gold"

In the complete line of Norton reinforced wheels you get the size, abrasive, reinforcing web and rubber or resinoid bond best suited to your work. These wheels bring you better production at lower costs . . . *because Norton builds in strength and safety that add the profit-boosting "Touch of Gold".*

In the many varieties of Norton reinforced wheels you'll find the just-right "combinations" that let you work fastest, safest, most profitably . . . your big advantages in dealing with the world's largest supplier of abrasives.

Also, Reinforced Mounted Wheels and Sticks

See your Norton distributor for further facts about reinforced abrasive products. Ask him for booklet No. 1748. Or write to NORTON COMPANY, General Offices, Worcester 6, Mass. Plants and distributors all around the world.

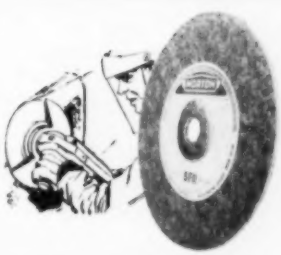
RN WHEELS
Glass Cloth

NEW

New — for the foundry and lower priced! Norton has been field-testing a new rubber-bonded-reinforced wheel. It's ready now and well worth your investigation for savings in your cutting-off operations on ferrous and non-ferrous metals.

BFR WHEELS
Cotton-Nylon

Top performers for light, portable grinding. These semi-flexible resinoid wheels have cotton fabric with an additional layer of Nylon for added safety. Specify A24KBFR for weld smoothing, removing scale, light finishing, minor cut-off jobs, etc.



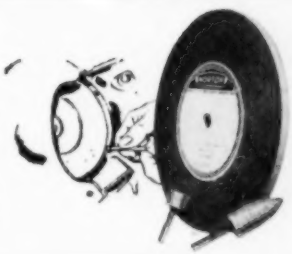
BN WHEELS
Glass Cloth

NOW — as thin as 1/16"

Ten-inch diameter wheels can now be had 1/16" and 3/32" thick. In this range specify A36TBN. For heavy duty work, requiring larger, thicker wheels, specify A24R14BN. Use them for slotting, for cutting-off non-ferrous metals, wire rope, many non-metallic materials.

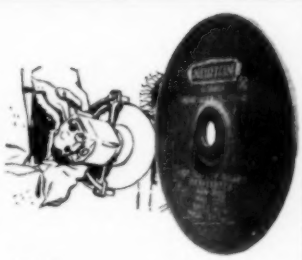
BF WHEELS
Cotton

These resinoid straight wheels with cotton fabric reinforcement are "the right combination" for peripheral grinding, do a fine job of deburring and finishing. Fine for blending and smoothing light welds. Also available in mounted wheels and sticks.



BD WHEELS
Glass-Nylon

For fastest cutting on right-angle grinders you'll want the glass cloth reinforced resinoid bonded hub wheels of rigid type. Use for medium to heavy weld grinding and smoothing flame-cut edges. Specify A24NBD for fast cut, A24QBD for long life. For cutting-off, A24RBD which is Nylon reinforced.



W-1811

NORTON
ABRASIVES

Making better products... to make your products better

NORTON PRODUCTS
Abrasives • Grinding Wheels • Grinding Machines • Refractories
BEHR-MANNING DIVISION:
Coated Abrasives • Sharpening Stones • Behr-cat Tapes

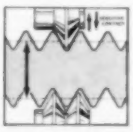
Eugene B. Power
Universal Microfilms
313 N. First St.
Ann Arbor, Mich.

... COSTS SO LITTLE TO SEE HOW YOU'RE DOING

THREAD GAGES

Pitch Diameter Gage Series 45

For fast inspection of pitch diameter of threads by roller contacts. Thread lead gage is also available.



Lead errors do not affect readings. Contacts engage one thread only.

You really know quickly and definitely how closely you are working to the required dimensional specifications when you use these and any of the many other Federal Dial Indicating Gages.

You see ahead of time whether you are taking off too much metal *before* you produce any scrap. You can see on the Dial Indicator just when you have obtained the correct dimension.

And you'll find these low cost gages will take care of the greater number of your requirements. There's no need of spending more money for more elaborate, higher priced gages except where their use is really necessary. Federal offers a big selection of gages from which you can select the best for your purpose. Do you have our catalog? If not, write

FEDERAL PRODUCTS CORPORATION
71511 Eddy Street • Providence 1, R. I.

COMPARATORS

OVER TEN TYPES

Universal Dial Comparator Model 100B-20

Highly accurate instrument. Attachments greatly extend gage's versatility.

SNAP GAGES

Indicating Crankshaft Gage Model 1340P-40

Extremely thin, measures diameter of crankshafts where projections are large and/or closely spaced.

DEPTH GAGES

Bench Type Indicating Depth Gage Model 75B-1

Long, 2" range.

GEAR GAGES

Pitch Diameter Gear Gages Series 202

Measure pitch diameter of spur gears, helical gears, splines, and chain sprockets — with either even or odd numbered teeth. Easy to use and reliably accurate.

INDICATING MICROMETER

Federal Mikemaster Model 200P-1

You read it more accurately. Always measures with same gaging pressure — provides uniform, accurate dial readings. Can be used as a Micrometer, or an Indicating Snap Gage.

CATALOG 55G

Shows most complete line of dial indicator gages. Send for your copy.

Ask **FEDERAL** *First*

FOR RECOMMENDATIONS IN MODERN GAGES . . .

Dial Indicating, Air, Electric, or Electronic — for Inspecting, Measuring, Sorting, or Automation Gaging